

Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 2009

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management



U.S. DEPARTMENT OF
ENERGY

Richland Operations
Office

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**RADIONUCLIDE AIR EMISSIONS REPORT
FOR THE HANFORD SITE, CALENDAR YEAR 2009**

ABSTRACT

This report documents radionuclide air emissions from the U.S. Department of Energy (DOE) Hanford Site in 2009 and the resulting highest effective dose equivalent (EDE) to a member of the public, referred to as the maximally exposed individual (MEI). The report has been prepared in compliance with the Code of Federal Regulations (CFR), Title 40, *Protection of the Environment*, Part 61, *National Emission Standards for Hazardous Air Pollutants* (NESHAP), Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities" and Washington Administrative Code (WAC) Chapter 246-247, "Radiation Protection—Air Emissions," as well as in accordance with the quality principles of 10 CFR 830, *Nuclear Safety Management*; DOE Order 414.1C, *Quality Assurance*, "Contractor Requirements Document"; NQA-1, *Quality Assurance Requirements for Nuclear Facility Application*; and EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans*.

Federal regulations in Subpart H of 40 CFR 61 require the measurement and reporting of radionuclides emitted from DOE facilities and the resulting public dose from those emissions. Those regulations impose a standard of 10 mrem/yr EDE, which is not to be exceeded. Washington State adopted the 40 CFR 61 standard of 10 mrem/yr EDE into their regulations that require the calculation and reporting of the EDE to the MEI from both point source emissions and from fugitive source emissions of radionuclides. WAC 246-247 further requires the reporting of radionuclide emissions, including radon, from all Hanford Site sources during routine and nonroutine operations.

The Clean Air Act Amendments of 1990 amended NESHAP regulations (i.e., 40 CFR 61 Subpart H) to govern emissions of radionuclides from DOE facilities. Those regulations are intended for the measurement of point source emissions but inclusive of fugitive emissions with regard to complying with the dose standard. Thereafter, the Hanford Site, besides complying with prescriptive NESHAP point source requirements, developed methods for measuring and evaluating fugitive emissions, in accordance with a Memorandum of Understanding (DOE, 1995) between DOE and the U.S. Environmental Protection Agency (EPA), as well as estimating associated doses. Since then, dose estimates from fugitive emissions have been considered when determining the state of Hanford Site compliance with the 10 mrem/yr EDE dose standard in 40 CFR Part 61 Subpart H adopted by reference in WAC 246-247.

The EDE to the Hanford Site MEI due to routine and nonroutine emissions in 2009 from Hanford Site point sources was 0.032 mrem (0.00032 milli-sievert [mSv]). The EDE from fugitive emissions at the Hanford Site in 2009 was 0.021 mrem (0.00021 mSv). The contribution from radon emissions in 2009 was 0.015 mrem (0.00015 mSv). The total radiological dose for 2009 to the MEI from all Hanford Site radionuclide emissions, including radon, was 0.068 mrem (0.00068 mSv), or 0.68 percent of the federal and state standard of 10 mrem/yr, to which the Hanford Site was in compliance.

The portions of the Hanford Site MEI dose attributable to individual point sources, as listed in Section 2.0, are appropriate for demonstrating the compliance status of abated stack emissions with applicable terms of the Hanford Site Air Operating Permit and of Notices of Construction.

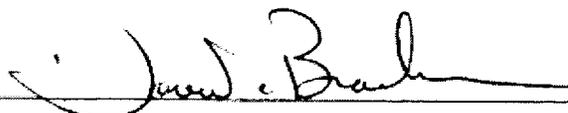
For further information concerning this report, you may contact Ms. Mary F. Jarvis, of the U.S. Department of Energy, Richland Operations Office, by telephone at (509) 376-2256 or by e-mail at Mary_F_Jarvis@rl.gov.

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CERTIFICATION OF DOE/RL-2010-17, REV. 0

***RADIONUCLIDE AIR EMISSIONS REPORT
FOR THE HANFORD SITE, CALENDAR YEAR 2009***

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. Sec. 18 U.S.C. 1001. [Verbatim from 40 CFR 61, Subpart H, 61.94(b)(9)]



D. A. Brockman, Manager
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6/29/2010
Date

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TERMS

AOP	Air Operating Permit
BNI	Bechtel National, Inc.
Bq	becquerel [i.e., one nuclear disintegration]
CAM	continuous air monitor
CAP-88	Clean Air Act Assessment Package-1988
CAP88-PC	Clean Air Act Assessment Package 1988-Personal Computer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CHPRC	CH2M HILL Plateau Remediation Company
Ci	curie [equals 3.7×10^{10} Bq]
CSB	Canister Storage Building
CVDF	Cold Vacuum Drying Facility
CWC	Central Waste Complex
D&D	decontamination and decommissioning
DCRT	double-contained receiver tank
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOE-ORP	U.S. Department of Energy, Office of River Protection
DOE-PNSO	U.S. Department of Energy, Pacific Northwest Site Office
DST	double-shell tank
EDE	effective dose equivalent
EDP	electronic data processing
ENCGS	Energy Northwest Columbia Generating Station
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ETF	200 Area Effluent Treatment Facility
FUA	Facility Use Agreement
FF-01	<i>Department of Energy Hanford Site Air Emissions License #FF-01</i>
FII	Fluor Hanford, Inc.
FFCA	<i>Federal Facility Compliance Agreement</i>
FFTF	Fast Flux Test Facility
FUA	Facility Use Agreement
GTF	Grout Treatment Facility
HEPA	high-efficiency particulate air (filter)
HT	elemental tritium
HTO	tritiated water
ISA	interim storage area
ISS	interim safe storage
IWTS	Integrated Water Treatment System
LAW	low-activity waste
LDR	Land Disposal Restriction
LLBG	Low-Level Burial Ground
LIGO	Laser Interferometer Gravitational Wave Observatory

major	a radioactive point source having a radiological dose potential of greater than 0.1 mrem/yr effective dose equivalent after all pollution-control equipment has been removed but operations are otherwise routine
MASF	Maintenance and Storage Facility
MEI	maximally exposed individual
minor	a radioactive point source having a radiological dose potential of less than or equal to 0.1 mrem/yr effective dose equivalent after all pollution-control equipment has been removed but are operations otherwise routine
MOU	Memorandum of Understanding
mrem	millirem [i.e., 1×10^{-3} rem]
MSA	Mission Support Alliance, LLC
mSv	millisievert [sievert = 100 rem]
MSC	Mission Support Contract
NA	not applicable
ND	not detected
NDA	nondestructive analysis
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFM	Near-Facility Monitoring
NOC	Notice of Construction
PCM	periodic confirmatory measurement
PFM	Plutonium Finishing Plant
PHMC	Project Hanford Management Contract
PNNL	Pacific Northwest National Laboratory
PRC	Plateau Remediation Contract
PTE	potential to emit
PTRAEU	portable temporary radioactive air emission unit
PUREX	Plutonium-Uranium Extraction (Plant)
PWR	pressurized-water reactor
QA	quality assurance
RCRA	<i>Resource Conservation and Recovery Act</i>
REDOX	Reduction-Oxidation (S Plant)
rem	roentgen equivalent man
RPL	Radiochemistry Processing Laboratory
SNF	spent nuclear fuel
SNM	special nuclear material
SST	single-shell tank
TEDF	Treated Effluent Disposal Facility
TRU	transuranic
TSCA	Toxic Substances Control Act of 1976
UO ₃ Plant	Uranium-Trioxide Plant
VLAW	very low-activity wastewater
WAC	Washington Administrative Code
WCH	Washington Closure Hanford, LLC
WDOH	Washington State Department of Health

WESF	Waste Encapsulation and Storage Facility
WIPP	Waste Isolation Pilot Plant
WRPS	Washington River Protection Solutions, LLC
WRAP	Waste Receiving and Processing Facility
WSCF	Waste Sampling and Characterization Facility
WSU	Washington State University
WTP	Waste Treatment and Immobilization Plant

1.0 INTRODUCTION

This report documents radionuclide air emissions from the U.S. Department of Energy (DOE) Hanford Site in 2009, and the resulting effective dose equivalent (EDE) to the maximally exposed individual (MEI) member of the public. The report complies with reporting requirements in the Code of Federal Regulations (CFR), Title 40, *Protection of the Environment*, Part 61, *National Emission Standards for Hazardous Air Pollutants*, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities" and in the Washington Administrative Code (WAC) Chapter 246-247, "Radiation Protection — Air Emissions." The report also is in accord with the quality principles of 10 CFR 830, *Nuclear Safety Management*; DOE Order 414.1C, *Quality Assurance*; NQA-1, *Quality Assurance Requirements for Nuclear Facility Application*; and EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans*.

1.1 HANFORD SITE DESCRIPTION

The Hanford Site (refer to Figure 1-1) is located in a rural region of southeastern Washington State, occupying an area of about 586 mi² (1,518 km²). It lies about 200 mi (320 km) northeast of Portland, Oregon; 170 mi (270 km) southeast of Seattle, Washington; and 124 mi (200 km) southwest of Spokane, Washington. More in-depth discussions on the characteristics and activities at the Hanford Site are available in the *Hanford Site National Environmental Policy Act (NEPA) Characterization* (PNNL-6415, Rev 18) and the *Hanford Site Environmental Report for Calendar Year 2009* (PNNL-19455).

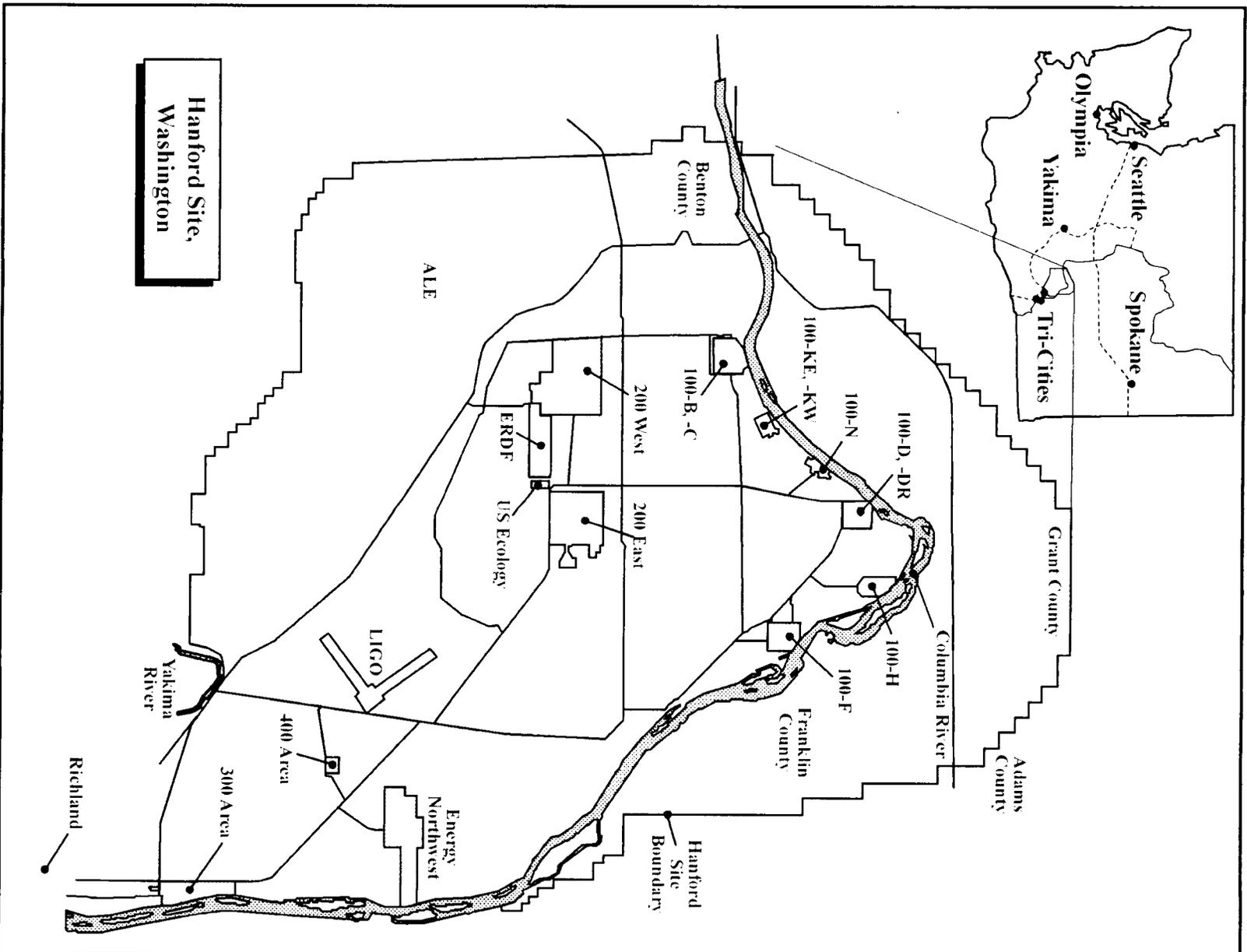
1.1.1 Historical Background

In 1943, the federal government acquired the land that became the Hanford Site, where facilities were constructed and operated as part of the atomic weapons program, which began during World War II. For more than 40 years, most facilities at the Hanford Site were dedicated to operations that produced plutonium for national defense and to managing the radioactive and chemical wastes generated from those production processes. In more recent years, defense programs have ceased while new programs have emerged. New programs include major efforts to clean up contamination in the environment and facilities resulting from past operational practices and the research and development of new and improved waste disposal technologies. Currently, three DOE Offices manage the programs at the Hanford Site. They are the U.S. Department of Energy, Richland Operations Office (DOE-RL), the U.S. Department of Energy, Office of River Protection (DOE-ORP), and the U.S. Department of Energy, Pacific Northwest Site Office (PNSO).

1.1.2 Main Areas, Facilities, and Activities

Five main operational areas at the Hanford Site generated radionuclide air emissions in 2009: the 100, 200, 300, 400, and 600 Areas (refer to Figure 1-1). The 100 Areas have the two deactivated 100-K Spent Fuel Storage Basins, the Cold Vacuum Drying Facility (CVDF), and nine deactivated production reactors with support facilities, all located near the Columbia River. The 200 Areas are located on a plateau approximately 21.5 mi (34.7 km) northwest of the City of Richland and 7 mi (11.3 km) from the Columbia River. Facilities in the 200 East Area include the Single-Shell and Double-Shell Tank Farms, Canister Storage Building (CSB), Waste Encapsulation and Storage Facility (WESF), Plutonium Uranium-Extraction (PUREX) Facility, B Plant Complex, Waste Treatment and Immobilization Plant (WTP), 242-A Evaporator, 200 Area Effluent Treatment Facility (ETF), Low-Level Burial Grounds, and the U.S. Ecology Low-Level Burial Site. In the 200 West Area are the Plutonium Finishing Plant (PFP), Uranium-Trioxide (UO₃) Plant, Single-Shell and Double-Shell Tank Farms, T Plant Complex, U Plant, Reduction-Oxidation (REDOX) Plant, 222-S Laboratory, Central Waste Complex (CWC), Waste Receiving and Processing (WRAP) Facility, and Low-Level Burial Grounds (LLBGs). The 300 Area,

Figure 1-1. Hanford Site Map.



just north of the City of Richland, has research and development laboratories. The 400 Area has the deactivated Fast Flux Test Facility (FFTF), 8 mi (12.9 km) north of the City of Richland. The 600 Area has the Environmental Restoration Disposal Facility (ERDF) and the Waste Sampling and Characterization Facility (WSCF); both facilities are immediately east of the 200 West Area.

Notable events in calendar year 2009 relevant to radioactive airborne emissions monitoring and reporting are summarized as follows:

- Environmental restoration activities continued along the river in the 100 and 300 Areas of the Hanford Site. Contaminated soil and debris from inactive waste sites were excavated, transported, and disposed of at ERDF as well as at other appropriate locations. Activities were conducted in the 100 Areas designed to place the retired nuclear reactors in interim safe storage (ISS) pending their final disposition. Those activities include decontamination and decommissioning of the reactors and of ancillary facilities. Several facilities in the 300 Area were decontaminated, decommissioned, and demolished.
- Significant amounts of waste were removed from some single-shell tanks (SSTs) in the 200 Area Tank Farms and transferred to the double-shell tank (DST) system.
- Bechtel National, Inc. (BNI) continued construction of WTP. Four major facilities are being constructed: the Pretreatment Facility, the High-Level Waste Vitrification Facility, the Low-Activity Waste Vitrification Facility, and the Analytical Laboratory. Through 2009, WTP has received no radioactive material; thus, no radioactive airborne emissions were released as a result of construction in 2009.
- The 200 Area Interim Storage Area continued storing spent fuel from non-defense production reactors in a dry-cask storage system.
- At PFP facilities, deactivation work continued under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).
- The 200 Area ETF continued treating radioactive-hazardous aqueous waste.
- The 242-A Evaporator continued operational campaigns to evaporate excess liquid from the DST waste system.
- The 222-S Laboratory continued characterizing tank waste and supporting Hanford operational and remediation projects.
- WSCF analyzed large numbers of effluent, environmental, and groundwater samples.
- FFTF was deactivated in June.

1.1.3 Prime Contractors

The DOE-RL prime contractors, along with their management responsibilities, are briefly described in this section.

- **CH2M HILL Plateau Remediation Company.** CH2M HILL Plateau Remediation Company (CHPRC) manages the Plateau Remediation Contract (PRC) at the Hanford Site. Summarized here are the principal contractual goals CHPRC is committed to advancing:

environmental remediation, decontamination, and decommissioning of facilities on the Central Plateau in the 200 Areas, where five chemical separations plants and other facilities separated and recovered plutonium and other materials used for national defense, including specifically

decontamination and demolition of facilities at PFP; groundwater monitoring and remediation; sitewide drilling management; characterization of facilities and waste sites; disposal activities of non-tank farm waste; environmental surveillance and maintenance; manage operations and as applicable the decontamination and demolition of facilities such as 100-K Area Spent Fuel Storage Basins, CVDF, CSB, PFP, FFTE, CWC, LLBG, WSCF, and T Plant Complex; monitor liquid effluents and air emissions; surveillance and maintenance of inactive facilities on the Central Plateau, such as the PUREX Facility, B Plant Complex, REDOX, U Plant, and the 209-E Building; and develop regulatory documents for activities related to groundwater, soil, and facilities.

- **Fluor Hanford, Inc. (FH)** FH managed the Project Hanford Management Contract (PHMC) for DOE-RL until October 1, 2008, when the majority of the PHMC technical scope of work was assigned to the new PRC, awarded to CHPRC. FH then segued into the role of an interim integrative contractor in relation to CHPRC and Washington River Protection Solutions, LLC (WRPS), for work with sitewide implications, until August 24, 2009, when it relinquished its responsibilities to the Mission Support Contract, LLC (MSA), who had been awarded the new Mission Support Contract (MSC), the scope of which is summarized next.
- **Mission Support Alliance, LLC.** MSA was awarded the MSC and began operations under authority of that contract from DOE-RL on August 24, 2009. MSA is responsible for fulfilling the MSC contractual goals, which include managing these five primary functions at the Hanford Site: Safety, security, and the environment; Site infrastructure and utilities; Site business management; information resources and content management; and portfolio management.
- **Washington Closure Hanford, LLC (WCH).** WCH manages the River Corridor Closure Project for DOE-RL. The scope of work includes surveillance and maintenance of inactive past-practice waste sites and of inactive facilities; remediation of past-practice waste sites; closure of Resource Conservation and Recovery Act of 1976 (RCRA) land-based treatment, storage, and disposal units; and the deactivation, decontamination, decommissioning, and demolition of facilities.

The DOE-ORP prime contractors at the Hanford Site are identified next, along with their management responsibilities and the facilities they oversee that have or have had radionuclide air emissions.

- **Bechtel National, Inc.** The mission of BNI is to design, build, and commission the Hanford Tank WTP to vitrify the tank waste at the Hanford Site. This project includes a pretreatment facility to separate the tank waste into high-level radioactive and low-activity radioactive streams. The High-Level Vitrification Facility and the Low-Level Vitrification Facility both will immobilize the waste in a glass form encased in canisters.
- **Washington River Protection Solutions, LLC.** WRPS manages the tank farms for DOE-ORP. These responsibilities include storing and retrieving for treatment of approximately 54 million gallons of highly radioactive and hazardous waste stored in 177 underground tanks; characterizing the waste; eventually delivering the waste to an under-construction vitrification facility at which the waste will be converted into a glass-like substance for permanent disposal.

The DOE-PNSO prime contractor at the Hanford Site is identified next, along with its management responsibilities and the facilities it oversees that have or have had radionuclide air emissions.

- **Battelle Memorial Institute.** Battelle Memorial Institute operates the Pacific Northwest National Laboratory (PNNL) for PNSO. PNNL does research and development in the physical, chemical, life, and environmental sciences; produces advanced methods of nuclear waste management; and conducts

relevant environmental monitoring on and off the Hanford Site and applicable liquid effluent and air emission monitoring at the DOE facilities it manages.

Some privately and publicly owned facilities capable of generating airborne radioactive emissions are located at or near the Hanford Site. These facilities include (1) a low-level waste burial site operated by U.S. Ecology on the 200 Area plateau, (2) the Energy Northwest Columbia Generating Station (ENCGS) commercial nuclear reactor and office buildings, near the Columbia River, north of the 300 Area and east of the 400 Area, (3) the Test America laboratory south of the 300 Area, (4) the AREVA Federal Services LLC fuel fabrication facility, adjacent to the Hanford Site southern boundary, (5) Perma-Fix Northwest, Inc., adjacent to the east side of the AREVA Federal Services LLC, (6) Interstate Nuclear Services, located 1 mi (1.6 km) south of the southern boundary of the Hanford Site, and (7) Battelle's non-DOE research laboratories in north Richland. Emissions from these facilities are not included in this report because they are not regulated as part of the Hanford Site; however, they may be separately regulated as required by applicable regulations.

1.2 POINT SOURCE DESCRIPTIONS

This section includes descriptions of point sources. A point source is reported in this document if it met the following four criteria during 2009: (1) required continuous monitoring or periodic confirmatory measurements in accordance with 40 CFR 61, Subpart H, and with WAC 246-247, (2) was described in the *Department of Energy Hanford Site Air Emissions License #FF-01* (FF-01), (3) emitted or had the potential to emit radionuclides, and 4) effluent sampling was the monitoring method used.

Air emissions from other sources of radioactive materials are reported in Sections 4.0 and 5.0. Fugitive emissions from those sources were estimated using methods described in Section 4.0.

1.2.1 General Description and Reporting Criteria

Radionuclide air emissions from point sources generally are discharged from stacks and vents (from this point forward, *stack* implies vent as well, unless vent is used as the proper name or description of a point source). Stack sizes, shapes, and discharge paths vary because of facility requirements at the time of construction. Discharge heights range from nearly ground level to 200 ft (61 m), and flow rates range from less than 100 ft³/min (0.047 m³/s) to 290,000 ft³/min (137 m³/s). Stacks vary in design from horizontal to vertical, rectangular to cylindrical, actively to passively ventilated, and permanent to portable.

A point source is designated "major" when hypothetically in the absence of all pollution control equipment its potential maximum emissions can cause a dose greater than 0.1 mrem/yr EDE to the nearest member of the public not employed by DOE or its contractors associated with the Hanford Site and who lives near and/or has unrestricted access to a place of employment on the Hanford Site. A point source is "minor" when under the same hypothetical conditions its potential maximum emissions in the absence of all pollution control equipment cannot cause a dose greater than 0.1 mrem/yr EDE.

These principal emission abatement methods were used singly or in combination to remove radioactive constituents from most stack emissions during 2009: (1) high-efficiency particulate air (HEPA) filters, (2) sand filters, (3) deep-bed fiberglass filters, (4) fiberglass prefilters, and (5) charcoal adsorbers. Generally, from one to three stages of HEPA filtration were used as the final particulate-removal method before an air emission stream was exhausted to the atmosphere. Other emission abatement technology employed at stacks includes: demisters, deentrainers, moisture separators, water chillers, condensers, evaporative towers, isolation and backdraft dampers, and so on (see Tables 2-3 and 2-4 for a listing of emission abatement technology at each stack).

1.2.2 100 Areas Facilities

The 100 Areas contain nine inactive production reactors and their associated support facilities. Many of the reactors have been placed in ISS and many associated support facilities demolished. The only point sources of radionuclide air emissions are at facilities in the 100-K and 100-N Areas. Those point sources are briefly described below and their locations illustrated in Figure 1-2.

1.2.2.1 100-N Area

The 100-N Area contains the inactive N Reactor and ancillary facilities.

107-N This minor CERCLA-regulated stack exhausted filtered air from activities conducted to decontaminate and decommission the inactive 107-N Basin Recirculation Facility. It was permanently shut down April 30, 2009. Particulate emissions were sampled prior to then.

1.2.2.2 100-K East and West Areas

Located in these areas are two retired reactors awaiting decommissioning, two storage basins that previously stored irradiated nuclear fuel under water, a radiological analysis laboratory, and the CVDF.

105-KE By September 2009, the three exhaust vents at the 105-KE Basin were permanently removed from service as part of the demolition of the facility housing the spent-fuel storage basin. All of the demolished material was disposed of at ERDF. When the vents did operate, emissions were sampled for particulate radionuclides and the data reported cumulatively because the vents exhausted a single point source. The vents were categorized as "minor" because the radiological dose potential of the associated point source was less than or equal to 0.1 mrem/yr EDE.

105-KW Three minor vents exhausted unfiltered air from the spent-fuel storage basin in the 105-KW Building. Emissions were sampled for particulate radionuclides and in Table 2-2 the analytical data reported cumulatively because the vents exhausted a single point source.

1706-KE This minor stack did not operate in 2009, having been shut down permanently near the end of 2008. When the stack did operate, it exhausted filtered air from the 1706-KE Laboratory. By September 2009, the above-grade portion of the laboratory, including the stack, was demolished and disposed of at ERDF.

296-K-142 This major stack exhausted filtered air from CVDF. The stack is categorized as "major" because the radiological dose potential of the associated point source is greater than 0.1 mrem/yr EDE. Particulate emissions were sampled.

100-KW Air Sparging Vent Air from the work area of the 105-KW Integrated Water Treatment System (IWTS) passively moves through this major vent, equipped with a single HEPA filter. During backwashing of system filters, radionuclides may become airborne and captured on the HEPA filter, which is destructively analyzed either quarterly if the air sparger was operated or annually if not.

1.2.3 200 East Area Facilities

The 200 East Area contains facilities for chemical separations, reprocessing, and waste handling and disposal. Locations of radionuclide air emission discharge points in the 200 East Area are illustrated in

Figure 1-3. The majority of radionuclides discharged from the 200 Areas are in particulate form. The PUREX Plant and Tank Farm evaporator facilities may still discharge a volatile radionuclide, ^{129}I .

1.2.3.1 Plutonium-Uranium Extraction Facility

The PUREX Facility was used to separate plutonium from spent nuclear fuel. The facility was deactivated in June 1997.

- 291-A-1 This major stack exhausted filtered air from the canyon. Emissions were sampled for particulate radionuclides and volatile ^{129}I .
- 296-A-10 This minor stack exhausted filtered air from Storage Tunnel No. 2. This stack has not operated since 1996. When it did operate, particulate emissions were sampled.

1.2.3.2 B Plant Complex

The B Plant Complex separated plutonium from spent nuclear fuel, but its operations were later reconfigured to remove ^{90}Sr and ^{137}Cs from highly radioactive liquid waste. The main canyon building, 221-B, contains radioactive contamination from various production campaigns. The B Plant Complex, excluding WESF, was deactivated in 1998.

- 296-B-1 This major stack, the replacement B Plant main stack, exhausted filtered air from the main canyon and process cells in the 221-B Building, from the process cell in the 212-B Building, and from the 224-B Building via the vessel vent. Particulate emissions were sampled.

1.2.3.3 Waste Encapsulation and Storage Facility

At WESF, ^{90}Sr and ^{137}Cs from waste separations material were converted to solid strontium fluoride and cesium chloride, respectively. Those cesium and strontium compounds were separately double-encapsulated and placed in water-filled storage basins at WESF. The current mission for WESF is to continue storing these radioactive capsules.

- 296-B-10 This major stack exhausted filtered air from the 225-B Building. Particulate emissions were sampled.

1.2.3.4 200 East Area Tank Farms

Radioactive waste stored in Tank Farms consists of sludge and saltcake in SSTs and liquids and slurry in DSTs.

- 296-A-18 This minor stack exhausted filtered air from the 241-AY-101 Tank annulus. Particulate emissions were sampled.
- 296-A-19 This minor stack exhausted filtered air from the 241-AY-102 Tank annulus. Particulate emissions were sampled.
- 296-A-20 This minor stack exhausted filtered air from the 241-AZ-101 and -102 Tank annuli. Particulate emissions were sampled.
- 296-A-26 This minor stack did not operate in 2009. When in use, it exhausts filtered air from the waste unloading room and sump tank at the 204-AR Waste Unloading Station.

- 296-A-28** This minor stack exhausted filtered air from the tank annuli in the 241-AW Tank Farm. Particulate emissions were sampled.
- 296-A-30** This minor stack exhausted filtered air from the tank annuli in the 241-AN Tank Farm. Particulate emissions were sampled.
- 296-A-40** This minor stack exhausted filtered air from the 241-AP tanks. Particulate emissions were sampled.
- 296-A-41** This minor stack exhausted filtered air from the tank annuli in the 241-AP Tank Farm. Particulate emissions were sampled.
- 296-A-42** This major stack exhausted filtered air from the tanks in the 241-AY and 241-AZ Tank Farms. Particulate and volatile radionuclide emissions were sampled.
- 296-A-43** This minor stack exhausted filtered building ventilation air from the 702-AZ Building. Ordinarily, particulate emissions are sampled, but in 2009 no samples were collected even though the stack operated. To compensate for this situation, the highest gross alpha and gross beta concentrations determined from sampling emissions from this stack during 2004 through 2008 were used as surrogates for estimating emission releases in 2009.
- 296-A-44** This major exhausted filtered air from the 241-AN tanks. It operates in conjunction with the 296-A-45 stack. Particulate emissions were sampled.
- 296-A-45** This major stack exhausted filtered air from the 241-AN tanks. It operates in conjunction with the 296-A-44 stack. Particulate emissions were sampled.
- 296-A-46** This major stack exhausted filtered air from the 241-AW tanks. It operates in conjunction with the 296-A-47 stack. Particulate emissions were sampled.
- 296-A-47** This major stack exhausted filtered air from the 241-AW tanks. It operates in conjunction with the 296-A-46 stack. Particulate emissions were sampled.
- 296-P-45** This portable exhauster did not operate in 2009. Although designated as a major stack, when last in use in 2007, it functioned as a minor point source. (**Note:** As a portable exhauster, it may be relocated to exhaust other emission points, which may include minor sources of emissions.) When last operated, particulate emissions were sampled.
- 296-P-47** This major stack, a portable exhauster, did not operate in 2009. It last operated in 2008, exhausting filtered air from the 241-C-109 tank to retrieve tank contents in support of activities leading to final tank closure. When operated, particulate material was sampled. (**Note:** As a portable exhauster, it may be relocated to exhaust other emission points, which may include minor sources of emissions.)
- 296-P-48** This major stack, a portable exhauster, exhausted filtered air from the 241-C-104 and -110 tanks during work to retrieve much of the remaining tank contents. (**Note:** As a portable exhauster, it may be relocated to exhaust other emission points, which may include minor sources of emissions.) Particulate emissions were sampled.

1.2.3.5 242-A Evaporator

The 242-A Evaporator operated in 2009 to remove liquid from DST liquid mixed waste to produce a more concentrated waste stream, which is transferred back to the Tank Farms.

- 296-A-21** This minor stack exhausted filtered air from the 242-A Building. Particulate emissions were sampled.
- 296-A-22** This minor stack exhausted filtered air from the 242-A Evaporator vessel ventilation system. During 242-A Evaporator campaigns, continuous sampling is required as well as measurement of radionuclides that could contribute greater than 10 percent of the potential total effective dose equivalent defined in the applicable Notice of Construction (NOC). During non-campaign periods, the requirement is that weekly samples of emissions collected once a quarter be analyzed for gross alpha and gross beta. In 2009, particulate emissions were sampled.

1.2.3.6 200 Area Effluent Treatment Facility

ETF treats mixed aqueous waste streams prior to their disposal at the State-Approved Land Disposal Site, also designated as the 616-A Crib.

- 296-E-1** This minor stack exhausted filtered air from the 2025-E Building and ETF processing vents. Particulate emissions were sampled.

1.2.3.7 Canister Storage Building

This facility stores irradiated fuel from the 100-K Spent Fuel Storage Basins. The fuel is contained in specially engineered canisters housed in storage tubes within the facility. Before the fuel was received at CSB, it passed through the CVDF, where it was dried and packaged in the canisters for shipment.

- 296-H-212** This major stack exhausted filtered air from the 212-H Building. Particulate emissions were sampled.

1.2.3.8 209-E Critical Mass Laboratory

This shutdown facility originally had been used for testing critical mass configurations, but has been in a surveillance-and-maintenance mode for years.

- 296-P-31** This major stack exhausted filtered building ventilation air from the 209-E Facility. Particulate emissions were sampled.

1.2.4 200 West Area Facilities

The 200 West Area contains facilities for laboratory analysis; chemical separations and processing; and waste handling and disposal. Locations of radionuclide air emission discharge points in the 200 West Area are illustrated in Figure 1-4.

1.2.4.1 Reduction-Oxidation Plant

REDOX also is known as the 202-S Building and as S Plant. REDOX operated as a fuel reprocessing facility until it was shut down in 1967.

- 291-S-1** The REDOX main stack exhausted filtered air from the REDOX canyon. Particulate emissions were sampled from this minor stack.

1.2.4.2 T Plant Complex

The T Plant Complex consists of two main structures: the 221-T Building and the 2706-T Building. The 221-T Building is one of the original fuel-processing facilities. The last fuel processed there was in 1956. The 221-T Building and the 2706-T Building are now used for the treatment, storage, repackaging, sampling, and verification of waste containers. Liquid waste was treated and stored in tank systems and radioactively contaminated equipment decontaminated in both structures.

- 291-T-1** This major stack exhausted filtered air from the 221-T Canyon, 224-T Process Cells, and process ventilation system. Particulate emissions were sampled.
- 296-T-7** This minor stack exhausted HEPA-filtered air from the 2706-T and 2706-TA Buildings when decontamination, treatment, storage, sampling, etc., activities were performed or other activities were underway that had the potential to increase airborne radionuclide contamination; otherwise, the stack does not operate. Particulate emissions were sampled.

1.2.4.3 U Plant

U Plant was constructed as a fuel reprocessing plant but never used for that purpose. Instead, it was used to recover uranium from bismuth-phosphate waste and high-level radioactive wastes from Tank Farms. U Plant is now a retired facility.

- 291-U-1** This minor stack exhausted filtered air from the 221-U Canyon ventilation system. Particulate emissions were sampled.

1.2.4.4 Plutonium Finishing Plant

PFP was constructed to produce plutonium metal from plutonium nitrate received from the PUREX Facility. PFP also recovered plutonium, in the form of plutonium nitrate, from plutonium scrap. Its prior missions have ended, missions which included the safe and secure storing of SNM and the stabilizing of nuclear materials for long-term storage. In 2009, significant cleanup activities were conducted, and in May 2009 the 291-Z-1, 296-Z-5, 296-Z-6, and 296-Z-7 stacks were transitioned to regulation under CERCLA.

- 291-Z-1** This major stack exhausted filtered air from the 234-5Z, 236-Z, and 242-Z Buildings. Particulate emissions were sampled.
- 296-Z-5** This minor stack exhausted filtered air from the 2736-ZB Building. Particulate emissions were sampled.
- 296-Z-6** This minor stack exhausted filtered air from the 2736-Z Building. Particulate emissions were sampled.
- 296-Z-7** This major stack exhausted filtered air from the 2736-ZB Building. Particulate emissions were sampled.
- 296-Z-15** This minor stack, regulated under CERCLA, exhausted filtered air from the 243-Z Liquid Low-Level Waste Treatment Facility. Particulate emissions were sampled.

1.2.4.5 200 West Area Tank Farms

These tank farms hold high-level radioactive waste, consisting of sludge and saltcake in SSTs and liquids and slurry in DSTs.

- 296-P-22** This minor stack exhausted filtered air from annuli in the 241-SY-101, -102, and -103 Tanks. Particulate emissions were sampled.
- 296-P-23** This minor stack exhausted filtered air from the 241-SY-101, -102, and -103 Tanks. Operation of this stack (designated as "B" train) alternated with 296-S-25 (designated as "A" train). Particulate emissions were sampled. In Table 2-2, emission and dose data for these two stacks are presented cumulatively because they exhaust a single point source.
- 296-P-43** This major stack, a portable exhauster, did not operate in 2009. (**Note:** As a portable exhauster, it may be relocated to exhaust other emission points, which may include minor sources of emissions.) It was last used at the 241-S-112 tank, where it exhausted filtered air from which particulate material was sampled.
- 296-P-44** This major stack is a portable exhauster. In 2009, it was used at Tank 241-S-102 to exhaust filtered air from which particulate material was sampled. (**Note:** As a portable exhauster, it may be relocated to exhaust other emission points, which may include minor sources of emissions.) Particulate emissions were sampled.
- 296-S-15** This minor stack did not operate in 2009 and is undergoing permanent closure. When in use, it exhausted filtered air from the 241-SX-101 through -112 and 241-SX-114 tanks, from which particulate material was sampled.
- 296-S-25** This minor stack exhausted filtered air from the 241-SY-101, -102, and -103 Tanks. Operation of this stack (designated as "A" train) alternated with 296-P-23 (designated as "B" train). Particulate emissions were sampled. In Table 2-2, emission and dose data for these two stacks are presented cumulatively because they exhaust the same point source.

1.2.4.6 200 West Area Evaporators

Two evaporators are in the 200 West Area: the 242-S Evaporator-Crystallizer Building and the 242-T Evaporator-Crystallizer Building. Both of these evaporators were shut down in the early 1980s. The evaporators were designed to remove most of the water from radioactive liquid waste, with the resulting slurry then rerouted to the Tank Farms for interim storage.

- 296-S-18** This minor stack exhausted filtered air from the 242-S Evaporator-Crystallizer Building. Particulate emissions were sampled.
- 296-T-17** This minor stack did not operate in 2009 and is undergoing permanent closure. When in use, it exhausted filtered air from the 242-T Evaporator-Crystallizer Building and cold-cell ventilation system.

1.2.4.7 222-S Laboratory

The 222-S Laboratory provides chemical and radiochemical analytical support for Tank Farm waste characterization, research and development, environmental sample analysis, and Hanford operation and remediation projects.

- 296-S-16** This minor stack exhausted filtered air from the 219-S Building waste tanks. Particulate emissions were sampled.
- 296-S-21** This major stack exhausted filtered air from 222-S Laboratory hoods, gloveboxes, hot-cells, and room ventilation system. Particulate emissions were sampled.
- 296-S-23** This minor stack exhausted filtered air from the 219-S Tank System Sample Gallery Hood. To verify low emissions from this stack, nondestructive analysis of the primary HEPA filter is performed every odd-numbered calendar year (when available, analysis results are presented in Table 5-3).

1.2.4.8 Waste Verification and Sampling Facility

The contents of drums received from generators used to be verified at this facility, which was transferred to West Tank Farms in 1995.

- 296-W-3** This minor stack did not operate in 2009, with no plans for it to operate again (it has not operated since 1997). When in use, it exhausted filtered air from the 213-W Building.

1.2.4.9 Waste Receiving and Processing Facility

WRAP is used for examining, assaying, characterizing, and repackaging waste, principally transuranic (TRU) waste.

- 296-W-4** This major stack exhausted filtered air from WRAP. Particulate emissions were sampled.

1.2.5 300 Area Facilities

The 300 Area consists primarily of laboratories, research facilities, a radioactive liquid waste handling facility, and several inactive facilities associated with prior Hanford Site missions. Many of these facilities have been demolished as part of CERLCA cleanup activities conducted in the 300 Area. Locations of emission points in the 300 Area are illustrated in Figure 1-5.

1.2.5.1 340 Complex

Within the 340 Complex is the 340-A Building, which contains six aboveground tanks that had been used to temporarily store liquid mixed waste. Those tanks have been flushed and are currently empty. The 340-B Building was used for the railcar loadout of liquid mixed waste and has been shut down since 1998. The 340-B Building is currently used to temporarily store nonradioactive and radioactive solid waste. The 340 Vault houses two tanks, which have been emptied to the maximum extent practical. Operations within the vaults have permanently ceased.

- 340-NT-EX** This minor stack exhausted filtered air from the 340 Building vault, the 340 Building vault tanks, the 340-A Building aboveground storage tanks, and the associated piping system. Particulate emissions were sampled.
- 340-B** This minor stack did not operate in 2009, with no plans for it to operate again. When last operated in 1998, it exhausted filtered air from the east portion of the 340-B Building.
- 340-DECON** This minor stack exhausted filtered air from the 340 Building Decon Room. Particulate emissions were sampled.

1.2.5.2 318 Radiological Calibrations Laboratory

The Radiological Calibration Laboratory contains areas for calibrating radiation survey instruments and processing personnel dosimeters. In the 318 Building, work is done with sealed sources and small quantities of unsealed sources. These sources are used for technical service and research purposes. Room 126 in the 318 Building is equipped with a fume hood that exhausts air flow through a single pass HEPA filter system to provide air emission controls and to help manage radioactive air releases.

EP-318-01-S This minor stack exhausted emissions from a single fume hood. Particulate emissions were sampled.

1.2.5.3 320 Analytical and Nuclear Research Laboratory

The Analytical and Nuclear Research Laboratory contains environmental radiochemistry laboratories. It has the capability of handling sealed sources. Also, unsealed sources of radioactive materials are handled in the form of fissionable materials, special nuclear materials, and high toxicity radioactive materials in certain quantities and limitations. The 320 Building has three permitted radioactive air exhaust stacks, two of which are connected to chemical hoods and the other is a building ventilation system stack.

EP-320-01-S This minor stack exhausted filtered building ventilation air. Particulate emissions were sampled.

EP-320-02-S This minor stack exhausted emissions from a filtered chemistry hood. Particulate emissions were sampled.

EP-320-04-S This minor stack did not operate. When it did operate, it exhausted emissions from a filtered chemistry hood, and particulate material in those emissions was sampled.

1.2.5.4 324 Waste Technology Engineering Laboratory

The building contains laboratories that were used for chemical and process development activities, and is now undergoing clean-out and deactivation under CERCLA.

EP-324-01-S This major stack exhausted filtered building air. Particulate emissions were sampled.

1.2.5.5 325 Radiochemical Processing Laboratory

The Radiochemical Processing Laboratory (RPL) contains radiochemistry laboratories and hot cells used for research process development, mixed-waste treatment activities, and radioanalytical services. The RPL manages radioactive inventory to the room, area, and building. The RPL is capable of handling sealed radioactive materials sources. Along with sealed sources, unsealed radioactive sources in the form of fissionable materials, special nuclear materials, and high toxicity radioactive materials are allowed within facility limitations. The 325 Building is operated as a major emission unit, ventilated through a series of HEPA filters and sampled via silica gel for tritium and record samples for particulate radionuclides.

Radionuclides monitored are those in actual inventory that contribute greater than 0.1 mrem/yr to the MEI, represent greater than 10 percent of the unabated potential to emit (PTE), or represent greater than 25 percent of the abated dose; other radionuclides that could (i.e., are not in actual inventory) contribute greater than 0.1 mrem/yr to the MEI, represent greater than 10 percent of the unabated PTE, or represent

greater than 25 percent of the abated dose are reported using the Appendix D method of 40 CFR 61. Radionuclides that do not meet the criteria above but have a known release are also reported.

EP-325-01-S This major stack exhausted filtered building air. Emissions were sampled using a record particulate sampler and a tritium sampler.

1.2.5.6 326 Materials Sciences Laboratory

The Materials Sciences Laboratory contains laboratories and equipment for studies of metallurgical, chemical, and physical behavior of reactor components, fuel materials, mixed fission products, mixed activation products, and ceramic composite materials. The 326 Building is capable of handling radioactive sealed sources. Unsealed radioactive sources handled in the building are fissionable materials, special nuclear materials, and high toxicity radioactive materials within allowable limits. These radioactive materials are handled in hot cells and fume hoods. The building has a radioactive air exhaust system that vents through HEPA filters.

EP-326-01-S This minor stack exhausted both filtered and unfiltered building air. Particulate emissions were sampled.

1.2.5.7 327 Post-Irradiation Testing Laboratory

The building, which contains hot-cells that had been used for examining and testing irradiated materials, was undergoing clean-out and deactivation under CERCLA. The EP-327-01-S stack was a major stack that was downgraded to a minor stack February 27, 2009. It was permanently shut down May 11, 2009.

EP-327-01-S This major and then minor stack exhausted filtered building air. Emissions were sampled using a record particulate sampler.

1.2.5.8 329 Chemical Sciences Laboratory

The Chemical Sciences Laboratory contains chemistry laboratories for radioanalytical studies, environmental radionuclide studies, and radiation detection instrumentation development. The 329 Building has the capability of handling radioactive sealed sources. Unsealed radioactive materials allowed are fissionable materials, special nuclear materials, and high toxicity radioactive materials in accordance with facility limitations. The building exhausts radioactive materials through a permitted exhaust stack.

EP-329-01-S This minor stack exhausted filtered building ventilation air. Particulate emissions were sampled.

1.2.5.9 331 Life Sciences Laboratory

The Life Sciences Laboratory I contains areas for biological and ecological research studies. The 331 Building is capable of handling sealed-source radioactive materials and unsealed radioactive sources such as fissionable materials and special nuclear materials. The Life Sciences Laboratory I is ventilated through a major emission unit.

Radionuclides monitored are those in actual inventory that contribute greater than 0.1 mrem/yr to the MEI, represent greater than 10 percent of the unabated PTE, or represent greater than 25 percent of the abated dose; other radionuclides that could (i.e., are not in actual inventory) contribute greater than 0.1 mrem/yr to the MEI, or represent greater than 10 percent of the unabated PTE, or represent greater

than 25 percent of the abated dose are reported using the Appendix D method of 40 CFR 61. Radionuclides that do not meet the criteria above but have a known release are also reported.

EP-331-01-V This major vent exhausted filtered building ventilation air. Particulate emissions were sampled.

1.2.6 400 Area Facilities

The 400 Area consists of the deactivated FFTF, the Maintenance and Storage Facility (MASF), and the Fuels Materials Examination Facility. Locations of emission points in the 400 Area are illustrated in Figure 1-6.

1.2.6.1 Fast Flux Test Facility

Deactivation of FFTF was completed in June 2009. Located in the 400 Area, it formally operated as a 400-megawatt thermal, sodium-cooled, low-pressure, high-temperature reactor plant, which had been constructed for irradiation testing of breeder reactor fuels and materials.

FFTF-RE-SB This minor stack did not operate in 2009 and is undergoing permanent closure. When it did operate it exhausted unfiltered air from the Lower Reactor Service Building and particulate emissions were sampled.

FFTF-CB-EX This minor stack, also referred to as the Combined Exhaust, operated only briefly in 2009, exhausting unfiltered air from the reactor containment and gases from the argon processing system. It ran only in support of maintenance activities. An agreement with the Washington State Department of Health (WDOH) allowed the discontinuance of emission sampling and the use instead of calculations based on residual contamination within the FFTF primary piping systems to estimate radioactive material emitted annually. Previously, emissions were sampled using a record sampler to collect particulate radionuclides and tritium in the form of tritiated water vapor.

FFTF-HT-TR This minor stack did not operate in 2009 and is undergoing permanent closure. When it did operate it exhausted air from unfiltered portions of the Heat Transport System South that are exterior to the FFTF containment structure and particulate emissions were sampled.

1.2.6.2 Maintenance and Storage Facility

MASF, or the 437 Building, is a multipurpose service center supporting the specialized maintenance and storage requirements of FFTF. MASF provides the capability for decontamination, repair, and storage of non-fueled components and hardware for FFTF.

437-MN&ST This minor stack exhausted filtered air from MASF. Particulate emissions were sampled.

437-1-61 This minor stack exhausted filtered air from MASF. Particulate emissions were sampled.

1.2.7 600 Area Facilities

In the 600 Area, WSCF emits or has the potential to emit radionuclides. For dose modeling purposes, WSCF was regarded as located in the 200 West Area because of its close proximity to the main entrance to that Area. Hence, WSCF is shown in Figure I-4.

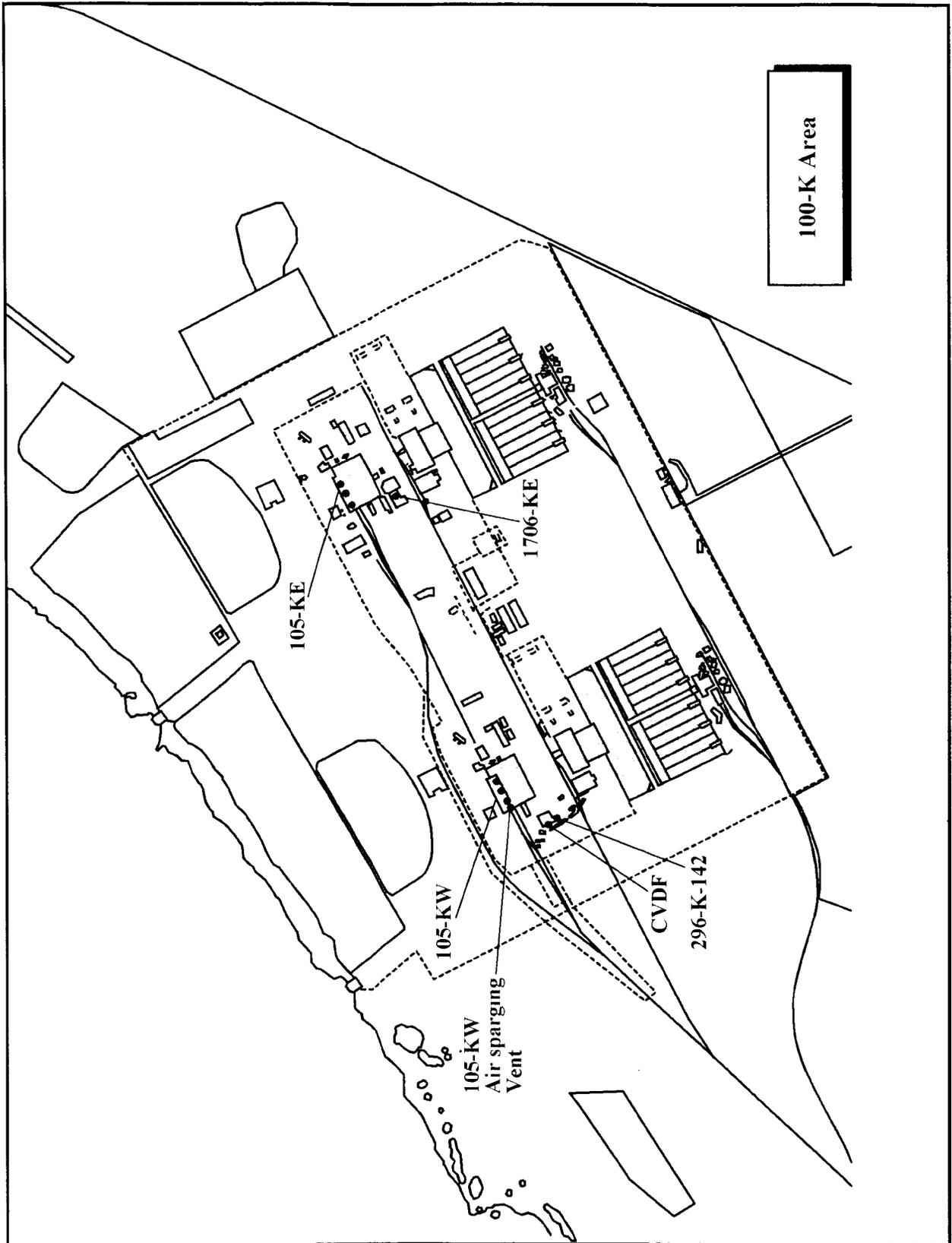
1.2.7.1 Waste Sampling and Characterization Facility

WSCF provides low-level radiological and chemical analyses on various types of samples and sample media. The majority of the analyzed samples are used to determine compliance with the requirements of environmental regulations and DOE Orders.

- 696-W-1** This minor stack exhausted filtered air from the analytical laboratory, on the main floor of the 6266 Building. Particulate emissions were sampled.

- 696-W-2** This minor stack exhausted filtered air from the Nuclear Spectroscopy Laboratory in the 6266 Building. Particulate emissions were sampled.

Figure 1-2. 100-K Area Radionuclide Emission Point Sources.



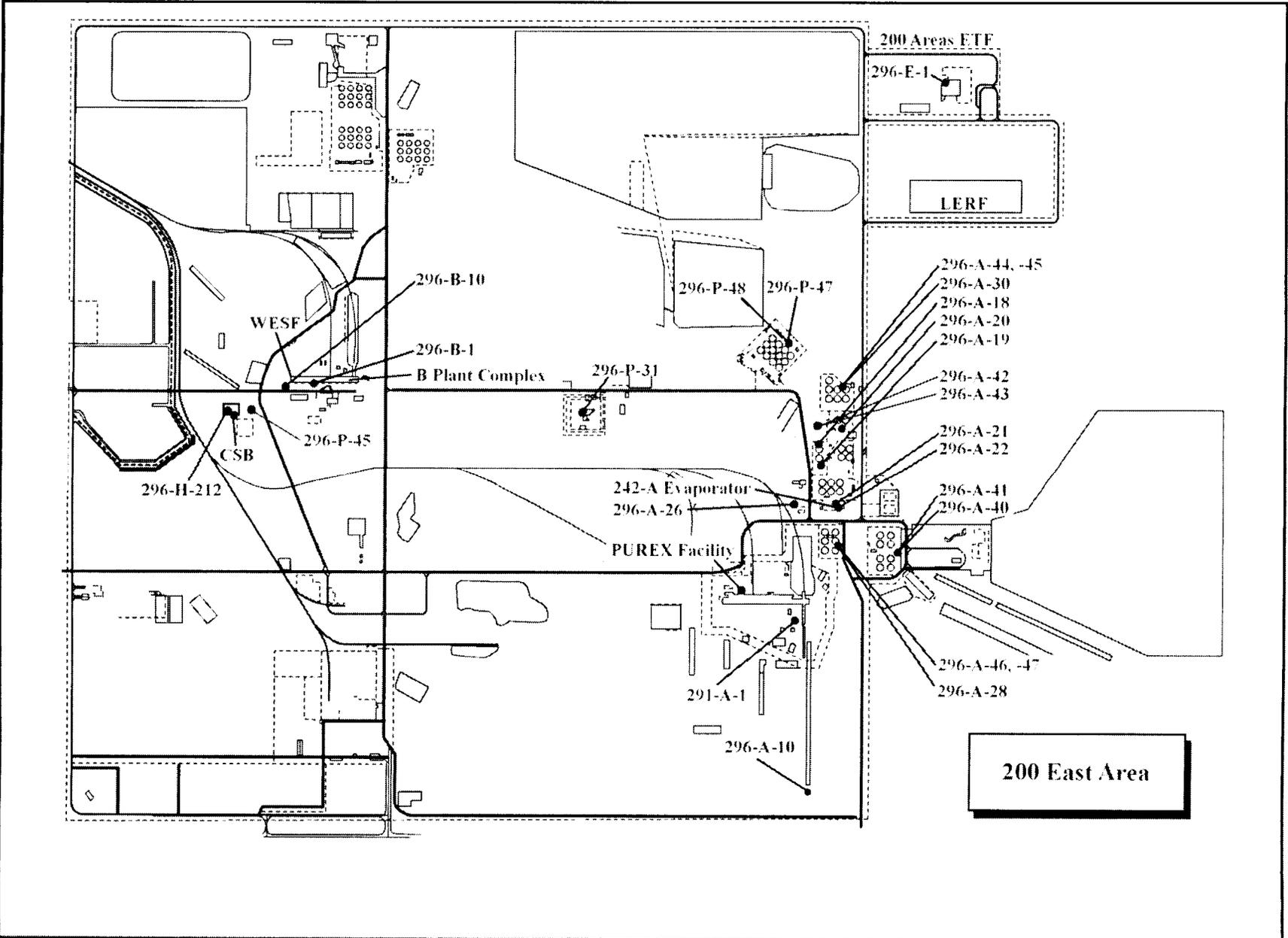


Figure I-3. 200 East Area Radionuclide Emission Point Sources.

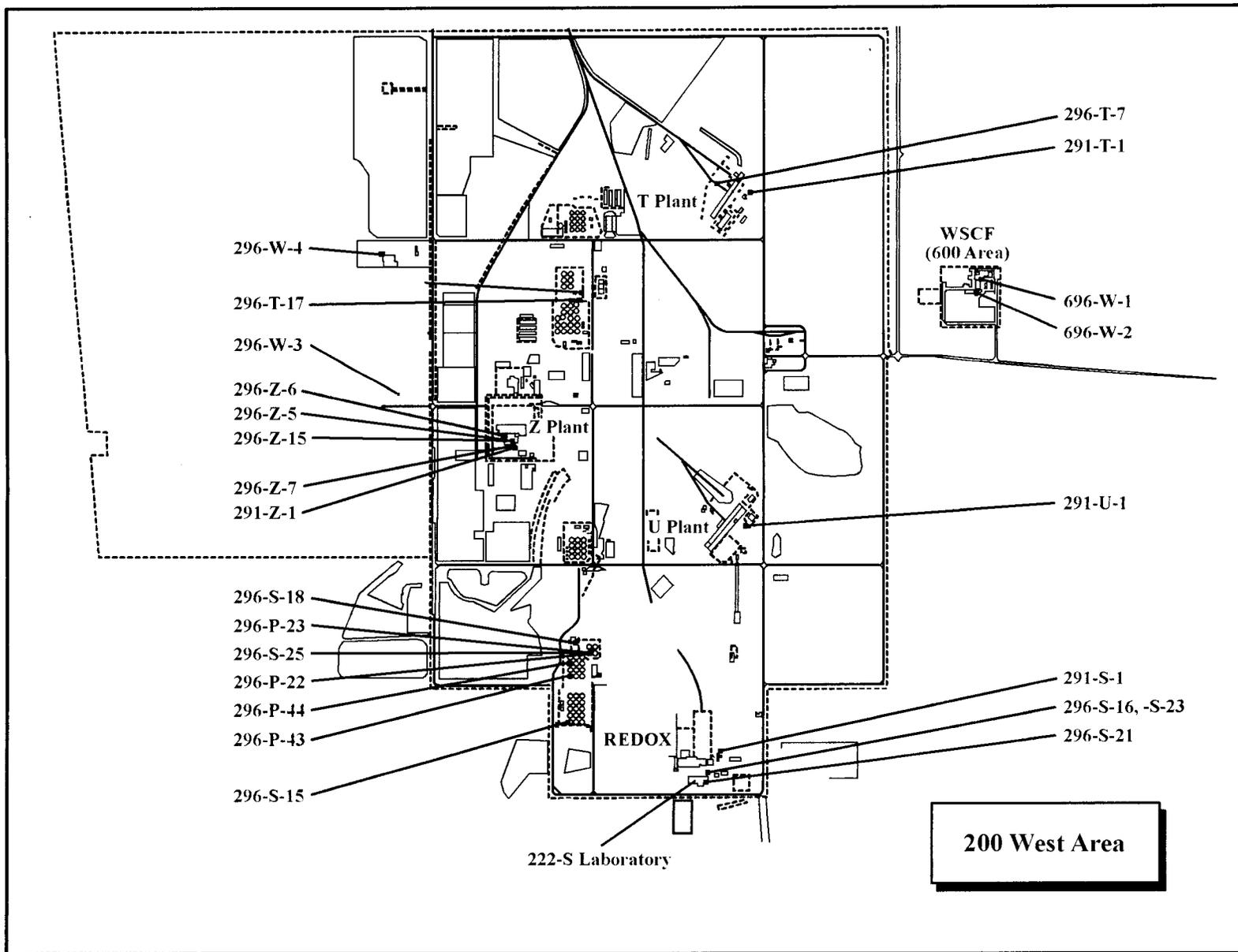


Figure 1-4. 200 West Area Radionuclide Emission Point Sources.

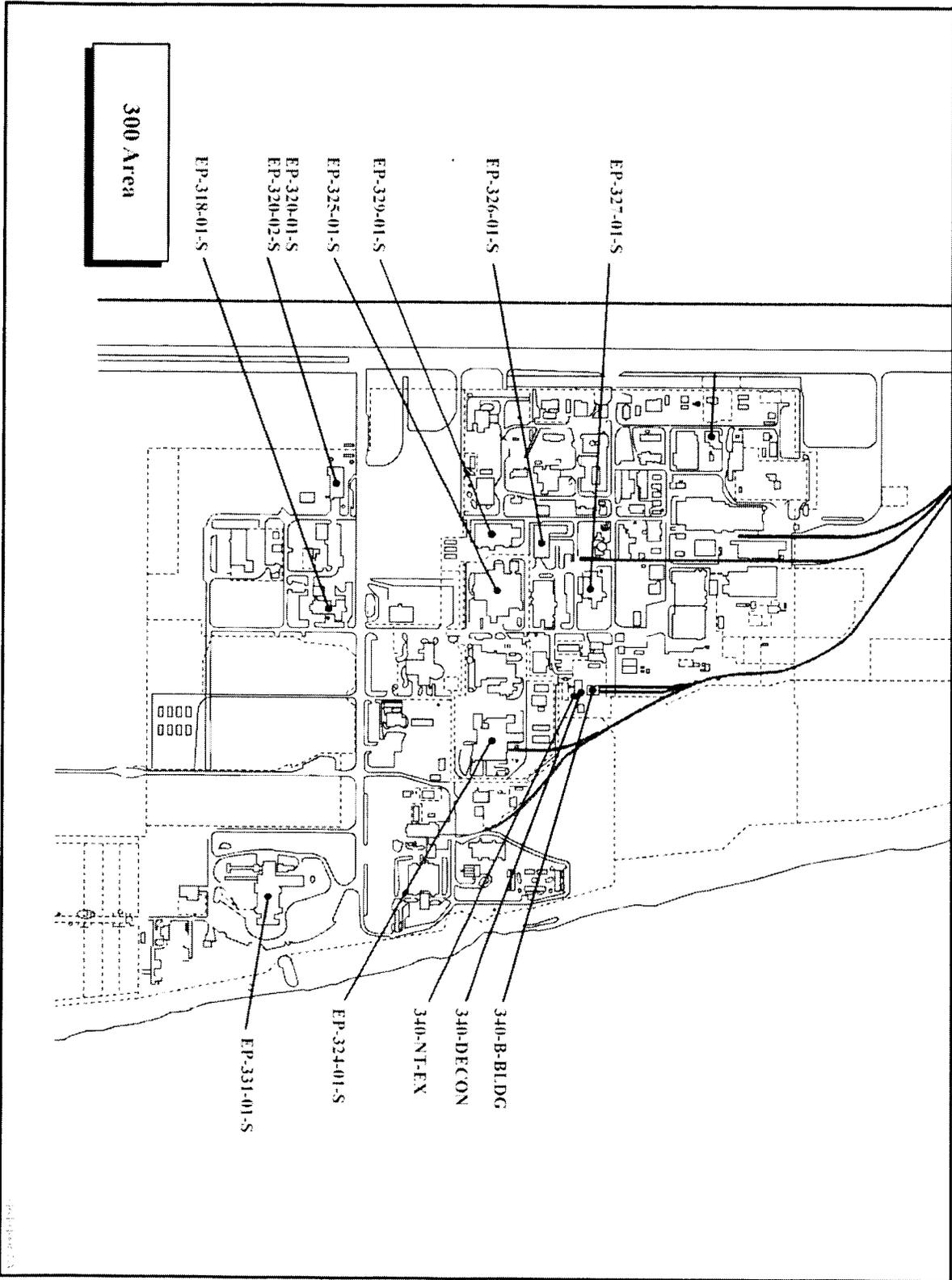
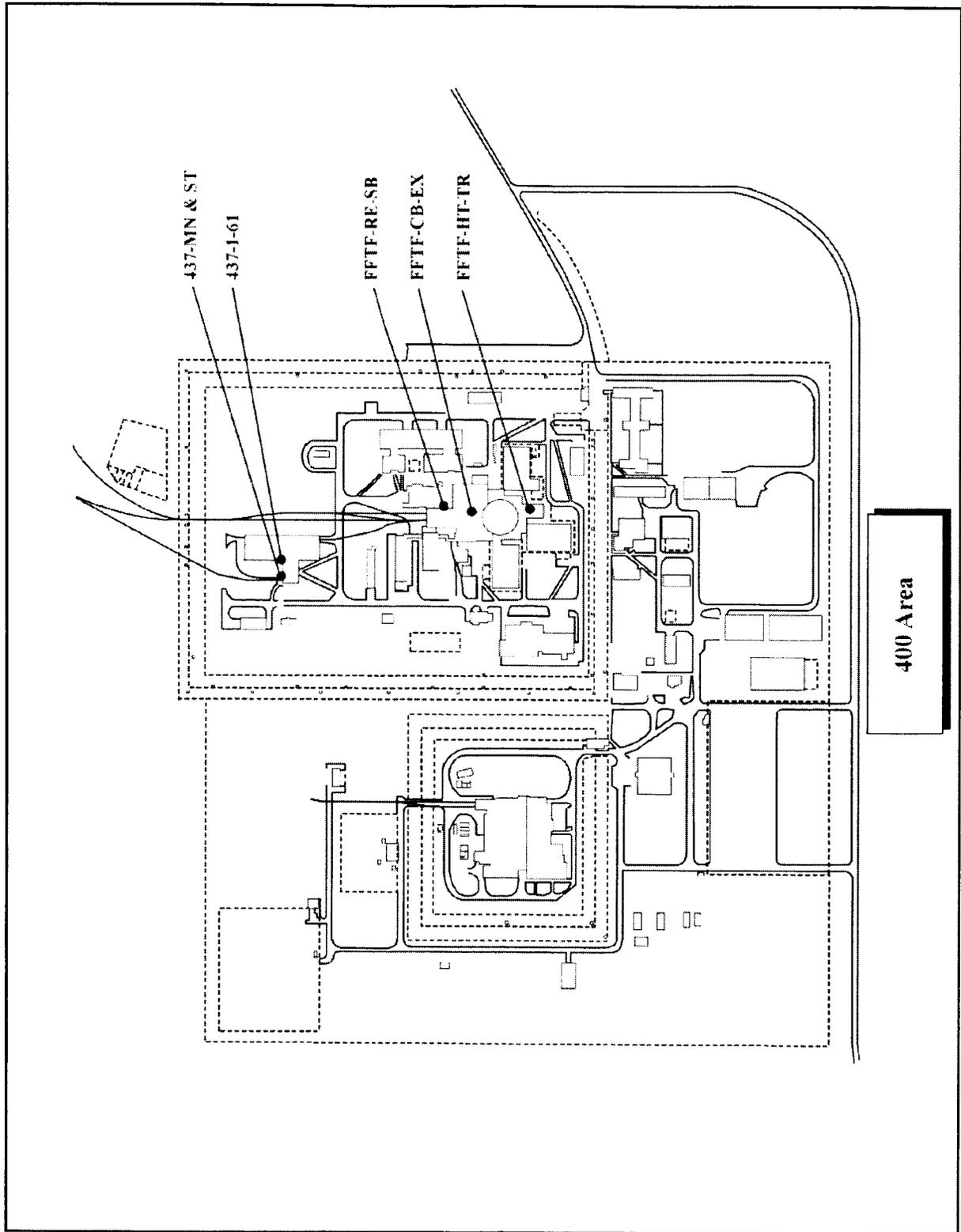


Figure 1-5. 300 Area Radionuclide Emission Point Sources.

Figure 1-6. 400 Area Radionuclide Emission Point Sources.



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2.0 RADIONUCLIDE AIR EMISSION DATA FOR POINT SOURCES

This section presents information on point sources of radionuclide emissions at the Hanford Site. The point sources listed are actively ventilated stacks using electrically powered exhausters and from which emissions are discharged under controlled conditions. The criteria for reporting point source radioactive emissions in this report are in Section 1.2. Data on radionuclides emitted from point sources in 2009 are shown in Tables 2-1 and 2-2.

Tables 2-1 and 2-2 display emission data of 25 major and 37 minor point sources, respectively, that operated during 2009 other than briefly for annual testing. Several point sources listed did not operate in 2009, and among them are a few that should never operate again but have not yet been officially and permanently deactivated. The data include total releases in 2009 of radionuclides or types of radioactivity from each point source and the consequent radiological doses from those releases. Tables 2-3 and 2-4 present information on stack heights and in-place abatement technology.

Each emission point is assigned to the major operational area in which it is located (i.e., 100, 200 East, 200 West, 300, or 400 Areas), except for two minor stacks in the 600 Area. For each of the operational areas, a nearest location (e.g., dwelling, business [which can be on an unrestricted area of the Hanford Site], school, or office) relative to that area is determined for a real or hypothetical public receptor not employed by DOE or its contractors and who has the potential of receiving the maximum exposure to emissions from that area. A common distance to that nearest public receptor is applied to all the emission points within an operational area; the two stacks in the 600 Area are for dose modeling treated as though located the 200 West Area. Thus, each of the five operational areas has assigned to it a respective location of a nearest public receptor. Radioactive doses calculated for these receptors are used to determine the regulatory category of each emission point source (i.e., whether it is major or minor) as well as requisite monitoring requirements. Information on these nearest receptors is in Table 2-5, including distances to the nearest farms that produce milk, meat, and vegetables.

In contrast to the five nearest public receptors is the Hanford Site MEI, a member of the public who hypothetically receives the highest calculated radiological dose attributable to exposure to Hanford Site emissions in one calendar year. Selection of the annual MEI, who cannot be an employee of DOE or its contractors, is contingent on the MEI's place of residence or employment (**Note:** A place of business may be at a location on the Hanford Site to which access is unrestricted, such as the Laser Interferometer Gravitational Wave Observatory [LIGO]). Emission data used in the calculations represent those from all point and fugitive sources in the five operational areas and in the 600 Area. For 2009, the MEI was a resident on a farm near Sagemoor Road, Franklin County, directly across the Columbia River from the Hanford Site 300 Area. This MEI location has remained unchanged since 2005. For 2004, the MEI location was Ringold, also the site of the MEI from 1990 through 1992. From 1993 through 1999, the MEI was at the Sagemoor Road location. In 2000 and 2001, the location of the MEI shifted to two different locations within the 300 Area where non-DOE-related employment existed. Such employment ended in early 2002.

The dose to the MEI was calculated using the dose-modeling program Clean Air Act Assessment Package 1988-Personal Computer (CAP88-PC) Version 3 (EPA 2007, *CAP88-PC Version 3.0 User Guide*), approved by the U.S. Environmental Protection Agency (EPA). This dose value is used in determining the status of Hanford Site compliance with the dose standard in 40 CFR 61, Subpart H, of 10 mrem/yr EDE to any member of the public.

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2009.
(radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)^d (6 sheets)

Stack (facility; contractor; EDP code) ^b	Average operating flow rate, ^c ft ³ /min (m ³ /s)	Volume, ft ³ (m ³)	Radionuclide or type of radioactivity ^d	Average operating concentration, ^c μCi/mL	Emissions, Ci	EDE to MEI, ^f mrem
100 Area Major Point Sources						
296-K-142 (CVDE/CHPRC: Y201)	16,375 (7.73)	8.6 E+09 (2.4 E+08)	⁹⁰ Sr	≤0	0	0
			¹³⁷ Cs	≤0	0	0
			^{239/240} Pu	≤0	0	0
			²⁴¹ Pu	≤0	0	0
			²⁴¹ Am	6.6 E-18	2.9 E-09	1.1 E-09
			gross α	8.9 E-17	3.9 E-08	1.8 E-08
			gross β	4.3 E-16	1.9 E-07	4.6 E-09
296-K-142 total dose: 2.4 E-08						
200 East Area Major Point Sources						
291-A-1 (PUREX Plant; CHPRC: A006)	30,359 (14.33)	1.6 E+10 (4.5 E+08)	⁹⁰ Sr	≤0	0	0
			¹²⁹ I	2.9 E-12	1.5 E-03	1.8 E-04
			¹³⁷ Cs	5.7 E-16	5.3 E-07	1.0 E-08
			^{239/240} Pu	1.7 E-16	1.6 E-07	9.8 E-08
			²⁴¹ Am	2.2 E-16	2.0 E-07	1.0 E-07
			gross α	8.5 E-16	7.9 E-07	4.8 E-07
			gross β	3.1 E-15	2.8 E-06	9.5 E-08
291-A-1 total dose: 1.8 E-04						
296-A-42 (TE: WRPS: F147)	560 (0.26)	2.9 E+08 (8.3 E+06)	⁹⁰ Sr	≤0	0	0
			¹²⁹ I	≤0	0	0
			¹³⁷ Cs	≤0	0	0
			^{239/240} Pu	≤0	0	0
			²⁴¹ Am	4.9 E-18	5.6 E-11	2.8 E-11
			gross α	3.7 E-17	4.3 E-10	2.6 E-10
			gross β	9.3 E-16	1.1 E-08	3.7 E-10
296-A-42 total dose: 6.6 E-10						
296-A-44 and 296-A-45 (TE: WRPS: F920 and F922, respectively [these two stacks exhaust the same source])	892 (0.42) and 1,024 (0.48)	4.9 E+08 (1.4 E+07)	¹⁴ C	NM	NM	NM
			⁹⁰ Sr	≤0	0	0
			⁹⁰ Y	≤0	0	0
			¹³⁴ Cs	≤0	0	0
			¹³⁷ Cs	≤0	0	0
			²²⁷ Ac	NM	NM	NM
			²³¹ Pa	NM	NM	NM
			²³³ U	NM	NM	NM
			²³⁸ Pu	≤0	0	0
			^{239/240} Pu	2.6 E-17	5.0 E-10	3.0 E-10
			²⁴¹ Am	5.3 E-18	1.0 E-10	5.0 E-11
²⁴⁴ Cm	NM	NM	NM			

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2009.
(radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)^a (6 sheets)

Stack (facility; contractor; EDP code) ^b	Average operating flow rate, ^c ft ³ /min (m ³ /s)	Volume, ft ³ (m ³)	Radionuclide or type of radioactivity ^d	Average operating concentration, ^e μCi/mL	Emissions, Ci	EDE to MEI, ^f mrem
			gross α	3.4 E-16	6.4 E-09	3.9 E-09
			gross β	1.8 E-15	3.5 E-08	1.2 E-09
296-A-44 and 296-A-45 total dose: 5.5 E-09						
296-A-46 and 296-A-47 (TF; WRPS: E924 and E926, respectively [these two stacks exhaust the same source])	1,063 (0.50) and 1,052 (0.50)	5.5 E+08 (1.6 E+07)	¹⁴ C	NM	NM	NM
			⁹⁰ Sr	≤0	0	0
			⁹⁰ Y	≤0	0	0
			¹³⁴ Cs	≤0	0	0
			¹³⁷ Cs	≤0	0	0
			²²⁷ Ac	NM	NM	NM
			²³¹ Pa	NM	NM	NM
			²³³ U	NM	NM	NM
			²³⁸ Pu	≤0	0	0
			^{239/240} Pu	1.0 E-16	2.1 E-09	1.3 E-09
			²⁴¹ Am	6.4 E-17	1.4 E-09	7.0 E-10
			²⁴⁴ Cm	NM	NM	NM
gross α	1.7 E-16	3.7 E-09	2.3 E-09			
gross β	1.3 E-15	2.7 E-08	9.2 E-10			
296-A-46 and 296-A-47 total dose: 5.2 E-09						
296-B-1 (B Plant; CHPRC: B001)	15,281 (7.21)	8.0 E+09 (2.3 E+08)	⁹⁰ Sr	≤0	0	0
			¹³⁷ Cs	≤0	0	0
			gross α	3.8 E-16	1.1 E-07	6.7 E-08
			gross β	3.3 E-15	9.2 E-07	3.1 E-08
296-B-1 total dose: 9.8 E-08						
296-B-10 (WESF; CHPRC: B748)	24,390 (11.51)	1.3 E+10 (3.6 E+08)	⁹⁰ Sr	2.4 E-13	1.1 E-04	3.7 E-06
			¹³⁷ Cs	1.3 E-13	5.8 E-05	1.1 E-06
			gross α	2.0 E-15	1.2 E-06	7.3 E-07
			gross β	6.7 E-13	3.9 E-04	1.3 E-05
296-B-10 total dose: 1.9 E-05						
296-H-212 (CSB; CHPRC: C601)	8,326 (3.93)	4.4 E+09 (1.2 E+08)	⁹⁰ Sr	≤0	0	0
			¹³⁷ Cs	≤0	0	0
			²³⁸ Pu	≤0	0	0
			^{239/240} Pu	≤0	0	0
			²⁴¹ Pu	≤0	0	0
			²⁴¹ Am	5.2 E-18	7.8 E-10	3.9 E-10
			gross α	3.9 E-16	5.9 E-08	3.6 E-08
gross β	8.8 E-16	1.3 E-07	4.4 E-09			
296-H-212 total dose: 4.1 E-08						

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2009.
(radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)^a (6 sheets)

Stack (facility; contractor; EDP code) ^b	Average operating flow rate, ^c ft ³ /min (m ³ /s)	Volume, ft ³ (m ³)	Radionuclide or type of radioactivity ^d	Average operating concentration, ^c μCi/mL	Emissions, Ci	EDE to MEI, ^f mrem
296-P-31 (209-F; CHPRC: F209)	5,500 (2.60)	2.9 E+09 (8.2 E+07)	²³⁸ Pu	≤0	0	0
			^{239/240} Pu	2.3 E-17	2.1 E-09	1.3 E-09
			²⁴¹ Pu	≤0	0	0
			²⁴¹ Am	1.7 E-17	1.6 E-09	8.0 E-10
			gross α	2.0 E-16	1.8 E-08	1.1 E-08
			gross β	1.4 E-15	1.3 E-07	4.4 E-09
296-P-31 total dose: 1.7 E-08						
296-P-45 (TE; WRPS: F047)	did not operate					
296-P-47 (TE; WRPS: F096)	did not operate					
296-P-48 (TE; WRPS: F098)	463 (0.22)	1.7 E+08 (4.9 E+06)	⁹⁰ Sr	≤0	0	0
			¹³⁷ Cs	≤0	0	0
			^{239/240} Pu	≤0	0	0
			²⁴¹ Am	≤0	0	0
			gross α	2.6 E-16	1.8 E-09	1.1 E-09
			gross β	1.7 E-15	1.1 E-09	3.7 E-10
296-P-48 total dose: 1.5 E-09						
200 West Area Major Point Sources						
291-T-1 (221-T; CHPRC: T785)	40,000 (18.88)	2.1 E+10 (6.0 E+08)	⁹⁰ Sr	1.6 E-17	1.2 E-08	4.4 E-10
			¹³⁷ Cs	7.2 E-16	5.4 E-07	1.1 E-08
			^{239/240} Pu	1.1 E-15	8.1 E-07	5.4 E-07
			²⁴¹ Pu	≤0	0	0
			²⁴¹ Am	1.0 E-16	7.9 E-08	4.3 E-08
			gross α	1.4 E-15	1.1 E-06	7.4 E-07
			gross β	3.5 E-15	2.6 E-06	9.6 E-08
291-T-1 total dose: 1.4 E-06						
291-Z-1 (PEP; CHPRC: Z810)	290,000 (136.87)	1.5 E+11 (4.3 E+09)	^{239/240} Pu	1.6 E-15	7.9 E-06	5.3 E-06
			²⁴¹ Pu	1.0 E-15	5.2 E-06	6.2 E-08
			²⁴¹ Am	4.4 E-16	2.2 E-06	1.2 E-06
			gross α	3.7 E-15	1.9 E-05	1.3 E-05
			gross β	8.6 E-16	4.3 E-06	1.6 E-07
			291-Z-1 total dose: 2.0 E-05			
296-P-43 (TE; WRPS: F045)	did not operate					

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2009. (radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)^a (6 sheets)

Stack (facility; contractor; EDP code) ^b	Average operating flow rate, ^c ft ³ /min (m ³ /s)	Volume, ft ³ (m ³)	Radionuclide or type of radioactivity ^d	Average operating concentration, ^c μCi/mL	Emissions, Ci	EDE to MEI, ^f mrem
296-P-44 (TF; WRPS; E046)	458 (0.22)	1.4 E+08 (3.9 E+06)	⁹⁰ Sr	2.6 E-15	1.4 E-08	5.2 E-10
			¹³⁷ Cs	2.6 E-14	1.4 E-07	2.9 E-09
			^{239/240} Pu	1.1 E-17	6.0 E-11	4.0 E-11
			²⁴¹ Am	3.5 E-17	1.9 E-10	1.0 E-10
			gross α	7.9 E-16	4.3 E-09	2.9 E-09
			gross β	4.4 E-14	2.4 E-07	8.9 E-09
			296-P-44 total dose: 1.5 E-08			
296-S-21 (222-S; WRPS; S289)	74,608 (35.21)	3.9 E+10 (1.1 E+09)	⁹⁰ Sr	≤0	0	0
			¹³⁷ Cs	≤0	0	0
			^{239/240} Pu	1.9 E-19	2.9 E-10	1.9 E-10
			²⁴¹ Am	1.3 E-17	1.9 E-08	1.0 E-08
			gross α	6.3 E-17	9.6 E-08	6.4 E-08
			gross β	4.3 E-16	6.5 E-07	2.4 E-08
296-S-21 total dose: 9.8 E-08						
296-W-4 (WRAP; CHPRC; W123)	15,079 (7.12)	7.9 E+09 (2.2 E+08)	⁹⁰ Sr	≤0	0	0
			¹³⁷ Cs	≤0	0	0
			²³⁸ Pu	≤0	0	0
			^{239/240} Pu	≤0	0	0
			²⁴¹ Pu	≤0	0	0
			²⁴¹ Am	9.4 E-18	2.9 E-09	1.6 E-09
			gross α	2.7 E-17	8.2 E-09	5.5 E-09
gross β	6.3 E-16	1.9 E-07	7.0 E-09			
296-W-4 total dose: 1.4 E-08						
296-Z-7 (PEP; CHPRC; Z818)	1,079 (0.51)	5.7 E+08 (1.6 E+07)	^{239/240} Pu	≤0	0	0
			²⁴¹ Pu	≤0	0	0
			²⁴¹ Am	4.3 E-18	8.9 E-11	4.9 E-11
			gross α	7.5 E-17	1.5 E-09	1.0 E-09
			gross β	6.8 E-16	1.4 E-08	5.2 E-10
296-Z-7 total dose: 1.6 E-09						
300 Area Major Point Sources						
EP-324-01-S (324 Building; WCH; E025 [under CERCLA ^g])	59,145 (27.91)	3.1 E+10 (8.8 E+08)	⁹⁰ Sr	≤0	0	0
			¹³⁷ Cs	≤0	0	0
			^{239/240} Pu	≤0	0	0
			²⁴¹ Am	1.3 E-17	1.3 E-08	4.6 E-07
			gross α	≤0	0	0
			gross β	1.8 E-16	1.9 E-07	3.6 E-07
EP-324-01-S total dose: 8.2 E-07						

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2009. (radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)¹ (6 sheets)

Stack (facility; contractor; EDP code) ^b	Average operating flow rate, ^c ft ³ /min (m ³ /s)	Volume, ft ³ (m ³)	Radionuclide or type of radioactivity ^d	Average operating concentration, ^e μCi/mL	Emissions, Ci	EDE to MEL, ^f mrem
EP-325-01-S (325 Building; PNNL; NA)	140,100 (66.12)	7.4 E+10 (2.1 E+09)	³ H (HT)	1.3 E-08	2.7 E+01	2.7 E-03
			³ H (HTO)	6.0 E-08	1.3 E+02	2.9 E-02
			¹⁴ C	2.4 E-14	5.0 E-05 ^h	5.3 E-07
			⁶⁰ Co	1.7 E-17	3.5 E-08 ⁱ	1.3 E-08
			⁸⁵ Kr	1.2 E-11	2.4 E-02 ^h	1.9 E-08
			⁹⁰ Sr	1.9 E-17	4.0 E-08	7.6 E-06
			⁹⁰ Y	5.3 E-10	1.1 E-04 ⁱ	1.5 E-07
			⁹⁹ Tc	1.9 E-11	4.0 E-06 ⁱ	1.4 E-06
			^{137m} Ba	5.0 E-16	3.0 E-06 ⁱ	2.6 E-11
			¹³⁷ Cs	4.9 E-17	1.0 E-07	1.1 E-07
			¹⁵¹ Sm	1.4 E-11	1.7 E-06 ⁱ	6.2 E-09
			¹⁵⁴ Eu	2.5 E-12	5.2 E-07 ⁱ	7.5 E-08
			¹⁵⁵ Eu	2.4 E-13	5.0 E-08 ⁱ	5.5 E-10
			¹⁸³ Ta	7.5 E-25	1.6 E-19 ⁱ	4.0 E-22
			¹⁸⁸ W	1.5 E-18	3.2 E-13 ⁱ	4.2 E-14
			²²⁸ Th	8.4 E-16	1.8 E-10 ⁱ	5.8 E-09
			²³² U	2.4 E-14	5.1 E-09 ⁱ	3.9 E-08
			²³² Th	4.8 E-16	1.0 E-10 ⁱ	2.1 E-09
			²³³ U	1.2 E-13	2.4 E-08 ⁱ	7.5 E-08
			²³⁴ U	2.9 E-15	6.0 E-10 ⁱ	1.8 E-09
			²³⁵ U	2.6 E-16	5.4 E-11 ⁱ	1.5 E-10
			²³⁶ U	1.1 E-16	2.3 E-11 ⁱ	6.4 E-11
			²³⁷ Np	2.3 E-19	4.8 E-10 ⁱ	9.2 E-09
			²³⁸ U	5.4 E-14	1.1 E-08 ⁱ	2.9 E-08
			²²⁰ Rn	2.6 E-08	5.4 E-01 ⁱ	see Table 3-5
			²²² Rn	3.3 E-10	7.0 E-01 ⁱ	see Table 3-5
			²³⁸ Pu	2.6 E-18	5.5 E-09	2.1 E-07
			^{239/240} Pu	5.2 E-18	1.1 E-08	4.6 E-07
			²⁴¹ Pu	≤0	0	0
			²⁴¹ Am	3.2 E-18	6.8 E-09	2.4 E-07
			²⁴² Pu	1.2 E-15	2.4 E-10 ⁱ	9.2 E-09
			²⁴³ Am	1.8 E-18	3.8 E-09 ⁱ	1.3 E-07
^{243/244} Cm	≤0	0	0			
²⁵² Cf	2.4 E-19	5.0 E-14 ⁱ	1.4 E-12			
gross α	≤0	0	0			
gross β	1.4 E-16	3.0 E-07	5.6 E-07			
EP-325-01-S total dose: 3.2 E-02						

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2009. (radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)^a (6 sheets)

Stack (facility; contractor; EDP code) ^b	Average operating flow rate, ^c ft ³ /min (m ³ /s)	Volume, ft ³ (m ³)	Radionuclide or type of radioactivity ^d	Average operating concentration, ^e μCi/mL	Emissions, Ci	EDE to MEI, ^f mrem
EP-327-01-S (327 Building: WCH; F026 [under CERCLA ^g])	23,000 (10.85)	4.3 E+09 (1.2 E+08)	⁹⁰ Sr	9.4 E-16	1.3 E-07	2.5 E-07
			¹³⁷ Cs	4.3 E-15	6.2 E-07	6.2 E-07
			²³⁸ Pu	8.0 E-17	1.1 E-08	4.3 E-07
			^{239/240} Pu	9.4 E-17	1.3 E-08	5.5 E-07
			²⁴¹ Am	1.9 E-16	2.7 E-08	9.5 E-07
			gross α	3.8 E-16	5.5 E-08	2.3 E-06
			gross β	8.3 E-15	1.2 E-06	2.3 E-06
EP-327-01-S total dose: 7.4 E-06						
EP-331-01-V (331 Building: PNNL: NA)	51,900 (24.49)	2.7 E+10 (7.7 E+08)	⁹⁰ Sr	3.5 E-17	2.7 E-08	5.1 E-08
			¹³⁷ Cs	≤0	0	0
			²³⁷ Np	1.6 E-14	1.3 E-07 ⁱ	2.4 E-06
			²³⁸ Pu	8.4 E-19	6.5 E-10	2.5 E-08
			^{239/240} Pu	8.0 E-18	6.2 E-09	2.6 E-07
			²⁴¹ Am	9.5 E-19	7.4 E-10	2.6 E-08
			²⁴³ Am	1.5 E-14	1.2 E-07 ⁱ	4.1 E-06
			gross α	5.1 E-17	4.0 E-08	1.7 E-06
gross β	2.6 E-16	2.0 E-07	3.8 E-07			
EP-331-01-V total dose: 8.9 E-06						

General definitions: ≤0 = analytical result equal to level of laboratory ambient background radioactivity or less than that level, which in practical terms means the radionuclide or type of radioactivity was not detected in the sample of the emission collected; Ci = curie; 1 Ci = 3.7 E+10 becquerels (Bq); ft³ = cubic feet; HT is tritium, or elemental tritium, in the form of an incondensable gas; HTO is tritiated water vapor, or tritium in the form of condensable water vapor; m³ = cubic meters; min = minute; mrem = millirem; NA = not applicable; NM = not measured; s = second; yr = year.

- ^a Determining the potential prospective dose impact of each point source necessitated using nearest public receptors, who may differ from the annually determined Hanford Site MEI.
- ^b Abbreviations and acronyms in this column are: CERCLA = Comprehensive Environmental Response, Conservation, and Liability Act of 1980; CHPRC = CH2M HILL Plateau Remediation Company; EDP code = electronic data processing code, used in chain-of-custody activities to identify sampling locations; PNNL = Pacific Northwest National Laboratory; PFP = Plutonium Finishing Plant; PUREX = Plutonium-Uranium Extraction; TF = Tank Farms; WCH = Washington Closure Hanford, LLC; WESF = Waste Encapsulation and Storage Facility; WRAP = Waste Receiving and Processing Facility; WRPS = Washington River Protection Solutions, LLC.
- ^c Reflects stack flow rate averaged over time of stack operation.
- ^d Radionuclides in bold typeface and within a shaded cell identify those required by 40 CFR 61, Subpart H, for mandatory sampling and analysis and as specified in HNF-1974, *Radionuclide National Emission Standards for Hazardous Air Pollutants Potential-to-Emit Assessment*, or as specified by facilities.
- ^e Reflects concentration averaged over time of stack operation.
- ^f EDE for MEI = effective dose equivalent for the maximally exposed individual; for calendar year 2009, the MEI was located near Sagemoor Road, Franklin County, directly across the Columbia River from the Hanford Site 300 Area.

- # Emissions from this point source are associated with cleanup operations conducted under the authority of CERCLA. Reporting those emissions in Table 2-1 demonstrates compliance with the monitoring requirements of 40 CFR 61, Subpart H, which is a substantive equivalent law (i.e., "applicable, relevant, or appropriate requirement") as defined by CERCLA.
- h Value based on release records.
- i Value not from actual measurements but calculated using estimated in-facility material inventories and Appendix D method of 40 CFR 61.
- j Release value conservatively calculated, not actually measured.

Table 2-2. Hanford Site Radionuclide Air Emissions from Minor Point Sources in 2009.
(radiological dose potential of ≤ 0.1 mrem/yr EDE to nearest public receptor)^a (5 sheets)

Stack (facility; contractor; EDP Code) ^b	Average operating flow rate, ^c ft ³ /min (m ³ /s)	Volume, ft ³ (m ³)	Radionuclide or type of radioactivity	Average operating concentration, ^d μ Ci/mL	Emissions, Ci	EDE to MEI, ^e mrem
100 Area Minor Point Sources						
105-KE Basin (100-K Area: CHPRC: Y245, Y246, Y248) did not operate; permanently shutdown						
105-KW Basin (100-K Area: CHPRC: Y234, Y235, Y236 [under CERCLA ^f])	17,700 (8.35)	9.3 E+09 (2.6 E+08)	⁹⁰ Sr	5.3 E-14	1.5 E-05	3.6 E-07
			¹³⁷ Cs	9.1 E-14	2.6 E-05	3.4 E-07
			¹⁵⁴ Eu	7.9 E-16	2.3 E-07	4.1 E-10
			²³⁸ Pu	5.1 E-15	1.5 E-06	6.5 E-07
			^{239,240} Pu	3.8 E-14	1.1 E-05	5.2 E-06
			²⁴¹ Pu	7.4 E-14	2.1 E-05	1.8 E-07
			²⁴¹ Am	2.9 E-14	8.5 E-06	3.3 E-06
			gross α	7.3 E-14	2.1 E-05	9.9 E-06
			gross β	3.0 E-13	8.8 E-05	2.1 E-06
105-KW Basin total dose:						2.2 E-05
107-N (100-N Area: WCH: Y265 [under CERCLA ^f])	6,998 (3.3)	1.2 E+09 (3.4 E+07)	gross α	≤ 0	0	0
			gross β	3.7 E-15	1.7 E-07	4.1 E-09
			107-N total dose:			
[Note: The 107-N stack was permanently shut down April 30, 2009.]						
1706-KE (100-K Area: CHPRC: Y243) did not operate; permanently shutdown						
200 East Area Minor Point Sources						
296-A-10 (PUREX: CHPRC: A550) did not operate; no plan to resume operation						
296-A-18 (TF: WRPS: E060)	287 (0.14)	1.3 E+08 (3.8 E+06)	gross α	2.8 E-15	1.4 E-08	8.5 E-09
			gross β	9.9 E-15	5.1 E-08	1.7 E-09
			296-A-18 total dose:			
296-A-19 (TF: WRPS: E061)	939 (0.44)	4.4 E+08 (1.2 E+07)	gross α	8.8 E-16	1.5 E-08	9.1 E-09
			gross β	3.0 E-15	5.1 E-08	1.7 E-09
			296-A-19 total dose:			
296-A-20 (TF: WRPS: E197)	1,823 (0.86)	8.3 E+08 (2.3 E+07)	gross α	1.1 E-16	3.0 E-09	1.8 E-09
			gross β	7.7 E-16	2.1 E-08	7.1 E-10
			296-A-20 total dose:			
296-A-21 (242-A Evaporator; WRPS: E645)	17,520 (8.27)	9.2 E+09 (2.6 E+08)	gross α	2.6 E-16	8.7 E-08	5.3 E-08
			gross β	9.7 E-16	3.2 E-07	1.1 E-08
			296-A-21 total dose:			

Table 2-2. Hanford Site Radionuclide Air Emissions from Minor Point Sources in 2009.
(radiological dose potential of ≤ 0.1 mrem/yr EDE to nearest public receptor)³ (5 sheets)

Stack (facility; contractor; EDP Code) ^b	Average operating flow rate, ^c ft ³ /min (m ³ /s)	Volume, ft ³ (m ³)	Radionuclide or type of radioactivity	Average operating concentration, ^d μ Ci/mL	Emissions, Ci	EDE to MEL, ^e mrem
296-A-22 (242-A Evaporator; WRPS: E643)	466 (0.22)	2.4 E+08 (6.9 E+06)	⁹⁰ Sr	≤ 0	0	0
			¹³⁷ Cs	1.1 E-16	9.4 E-10	1.8 E-11
			²³⁸ Pu	≤ 0	0	0
			^{239,240} Pu	≤ 0	0	0
			²⁴¹ Am	≤ 0	0	0
			gross α	2.3 E-16	2.0 E-09	1.2 E-09
			gross β	2.5 E-15	2.2 E-08	1.8 E-10
296-A-22 total dose: 2.0 E-09						
296-A-26 (TE: WRPS: E297) did not operate						
296-A-28 (TE: WRPS: E272)	4,536 (2.14)	1.9 E+09 (5.5 E+07)	gross α	1.1 E-15	1.2 E-07	7.3 E-08
			gross β	3.7 E-15	4.3 E-07	1.5 E-08
296-A-28 total dose: 8.8 E-08						
296-A-30 (TE: WRPS: E903)	5,547 (2.62)	2.2 E+09 (6.2 E+07)	gross α	2.7 E-16	3.0 E-08	1.8 E-08
			gross β	4.0 E-15	4.6 E-07	1.6 E-08
296-A-30 total dose: 3.4 E-08						
296-A-40 (TE: WRPS: E013)	853 (0.40)	4.5 E+08 (1.3 E+07)	gross α	2.5 E-16	4.0 E-09	2.4 E-09
			gross β	4.1 E-15	6.4 E-08	2.2 E-09
296-A-40 total dose: 4.6 E-09						
296-A-41 (TE: WRPS: E015)	7,609 (3.59)	4.0 E+09 (1.1 E+08)	gross α	4.7 E-16	6.7 E-08	4.1 E-08
			gross β	1.5 E-15	2.1 E-07	7.1 E-09
296-A-41 total dose: 4.8 E-08						
296-A-43 (TE: WRPS: E148)	847 (0.40)	4.5 E+08 (1.3 E+07)	gross α	1.5 E-15	2.6 E-08	1.6 E-08
			gross β	2.7 E-15	4.7 E-08	1.6 E-09
296-A-43 total dose: 1.8 E-08						
296-E-1 (ETE: CHPRC: E036)	55,954 (26.41)	2.9 E+10 (8.3 E+08)	gross α	2.0 E-16	2.3 E-07	1.4 E-07
			gross β	5.9 E-16	6.7 E-07	2.3 E-08
296-E-1 total dose: 1.6 E-07						
200 West Area Minor Point Sources						
291-S-1 (REDOX Plant: CHPRC: S006)	18,194 (8.59)	9.6 E+09 (2.7 E+08)	gross α	3.6 E-16	1.3 E-07	8.7 E-08
			gross β	4.7 E-15	1.7 E-06	6.3 E-08
291-S-1 total dose: 1.5 E-07						
296-P-22 (TE: WRPS: W191)	880 (0.42)	4.6 E+08 (1.3 E+07)	gross α	2.1 E-16	3.5 E-09	2.3 E-09
			gross β	1.2 E-15	2.0 E-08	7.4 E-10
296-P-22 total dose: 3.0 E-09						
296-P-23 (W190) and 296-S-25 (W145) (TE: WRPS: [stacks operate alternately exhausting a single source])	1,020 (0.48) and 901 (0.43)	4.7 E+08 (1.3 E+07) [combined total for both stacks]	gross α	2.5 E-16	4.3 E-09	2.9 E-09
			gross β	1.5 E-15	2.6 E-08	9.7 E-10
296-P-23 and 296-S-25 combined total dose: 3.8 E-09						

Table 2-2. Hanford Site Radionuclide Air Emissions from Minor Point Sources in 2009.
(radiological dose potential of ≤ 0.1 mrem/yr EDE to nearest public receptor)^a (5 sheets)

Stack (facility; contractor; EDP Code) ^b	Average operating flow rate, ^c ft ³ /min (m ³ /s)	Volume, ft ³ (m ³)	Radionuclide or type of radioactivity	Average operating concentration, ^d μ Ci/mL	Emissions, Ci	EDE to MEI, ^e mrem
296-S-15 (TF; WRPS; W111) did not operate; no plan to resume operation						
296-S-16 (222-S; WRPS; S264)	39 (0.02)	2.0 E+07 (5.8 E+05)	gross α	1.1 E-15	8.4 E-10	5.6 E-10
			gross β	9.1 E-15	7.2 E-09	2.7 E-10
			296-S-16 total dose: 8.3 E-10			
296-S-18 (TF; WRPS; W096)	2,794 (1.32)	4.8 E+08 (1.4 E+07)	gross α	3.3 E-16	6.5 E-09	4.4 E-09
			gross β	3.0 E-15	6.0 E-08	2.2 E-09
			296-S-18 total dose: 6.6 E-09			
296-T-7 (2706-T; CHPRC; T154)	166 (0.08)	8.7 E+07 (2.5 E+06)	¹³⁷ Cs	≤ 0	0	0
			gross α	≤ 0	0	0
			gross β	≤ 0	0	0
			296-T-7 total dose: 0			
296-T-17 (TF; WRPS; W117) did not operate; no plan to resume operation						
291-U-1 (U Plant; CHPRC; U771) [under CERCLA ^f]	20,509 (9.68)	1.1 E+10 (3.1 E+08)	⁹⁰ Sr	2.4 E-15	9.8 E-07	3.6 E-08
			¹⁰⁶ Ru	7.7 E-16	3.2 E-07	4.9 E-10
			¹³⁷ Cs	2.4 E-14	1.0 E-05	2.1 E-07
			²³⁴ U	8.4 E-17	3.5 E-08	1.7 E-09
			²³⁵ U	5.3 E-18	2.2 E-09	9.6 E-11
			²³⁷ Np	1.1 E-16	1.8 E-09	5.0 E-09
			²³⁸ U	8.0 E-17	3.4 E-08	1.4 E-09
			²³⁸ Pu	≤ 0	0	0
			^{239,240} Pu	3.7 E-17	1.5 E-08	1.0 E-08
			²⁴¹ Am	1.7 E-17	7.2 E-09	4.0 E-09
			gross α	2.3 E-16	9.6 E-08	6.4 E-08
			gross β	2.5 E-14	1.0 E-05	3.7 E-07
291-U-1 total dose: 7.0 E-07						
296-Z-5 (PEP; CHPRC; Z913)	10,265 (4.84)	5.4 E+09 (1.5 E+08)	gross α	≤ 0	0	0
			gross β	≤ 0	0	0
			296-Z-5 total dose: 0			
296-Z-6 (PEP; CHPRC; Z802)	14,000 (6.61)	7.4 E+09 (2.1 E+08)	gross α	1.1E-16	3.2E-08	2.1 E-08
			gross β	8.6E-16	2.5E-07	9.2 E-09
			296-Z-6 total dose: 3.0 E-08			
296-Z-15 (PEP; CHPRC; Z915) [under CERCLA ^f]	1,378 (0.65)	7.2 E+08 (2.1 E+07)	gross α	≤ 0	0	0
			gross β	≤ 0	0	0
			296-Z-15 total dose: 0			

Table 2-2. Hanford Site Radionuclide Air Emissions from Minor Point Sources in 2009.
(radiological dose potential of ≤ 0.1 mrem/yr EDE to nearest public receptor)ⁱ (5 sheets)

Stack (facility; contractor; EDP Code) ^b	Average operating flow rate, ^c ft ³ /min (m ³ /s)	Volume, ft ³ (m ³)	Radionuclide or type of radioactivity	Average operating concentration, ^d μ Ci/mL	Emissions, Ci	EDE to MEI, ^e mrem
300 Area Minor Point Sources						
340-B (340 Complex; CHPRC; F008) did not operate: locked out, no plan to resume operations						
340-DECON (340 Complex; CHPRC; F009)	7,249 (3.42)	3.8 E+09 (1.1 E+08)	gross α	≤ 0	0	0
			gross β	5.1 E-16	7.5 E-08	1.4 E-07
340-DECON total dose: 1.4 E-07						
340-NT-EX (340 Complex; CHPRC; F002)	1,420 (0.67)	7.5 E+08 (2.1 E+07)	gross α	≤ 0	0	0
			gross β	3.4 E-16	8.3 E-09	1.6 E-08
340-NT-EX total dose: 1.6 E-08						
EP-318-01-S (318 Building; PNNL; NA)	531 (0.25)	2.8 E+08 (7.9 E+06)	³ H (HT)	3.1 E-10	1.4 E-05 ^e	1.4 E-09
			⁸⁵ Kr	1.6 E-12	9.3 E-06 ^e	7.2 E-12
			gross α	≤ 0	0	0
			gross β	5.5 E-16	4.3 E-09	8.2 E-09
EP-318-01-S total dose: 9.6 E-09						
EP-320-01-S (320 Building; PNNL; NA)	28,600 (13.50)	1.5 E+10 (4.3 E+08)	gross α	4.1 E-18	1.7 E-09	7.3 E-08
			gross β	2.1 E-15	9.0 E-07	1.7 E-06
EP-320-01-S total dose: 1.8 E-06						
EP-320-02-S (320 Building; PNNL; NA)	528 (0.25)	2.8 E+08 (7.9 E+06)	gross α	3.6 E-16	2.8 E-09	1.2 E-07
			gross β	3.0 E-15	2.4 E-08	4.5 E-08
EP-320-01-S total dose: 1.6 E-07						
EP-320-04-S (320 Building; PNNL; NA) did not operate						
EP-326-01-S (326 Building; PNNL; NA)	43,900 (20.72)	2.3 E+10 (6.5 E+08)	³ H (HT)	5.5 E-15	3.6 E-06 ^e	8.3 E-10
			^{131m} Xe	1.5 E-19	1.0 E-10 ^e	1.1 E-16
			¹³⁵ Xe	2.8 E-18	1.8 E-09 ^e	7.9 E-15
			²²² Rn	7.7 E-18	5.0 E-09 ^e	2.8 E-11
			gross α	5.7 E-16	3.7 E-07	1.6 E-05
			gross β	7.9 E-15	5.1 E-06	9.8 E-06
EP-326-01-S total dose: 2.6 E-05						
EP-329-01-S (329 Building; PNNL; NA)	44,900 (21.19)	2.4 E+10 (6.7 E+08)	^{131m} Xe	7.5 E-18	5.0 E-09 ^e	5.7 E-15
			¹³⁵ Xe	2.0 E-16	1.4 E-07 ^e	5.9 E-13
			gross α	1.7 E-17	1.1 E-08	4.8 E-07
			gross β	7.0 E-17	4.7 E-08	8.9 E-08
EP-329-01-S total dose: 5.7 E-07						
400 Area Minor Point Sources						
437-1-61 (MASE; CHPRC; F019)	14,914 (7.04)	7.8 E+09 (2.2 E+08)	gross α	≤ 0	0	0
			gross β	1.2 E-15	3.6 E-07	4.7 E-08
437-1-61 total dose: 4.7 E-08						

Table 2-2. Hanford Site Radionuclide Air Emissions from Minor Point Sources in 2009.
(radiological dose potential of ≤ 0.1 mrem/yr EDE to nearest public receptor)^a (5 sheets)

Stack (facility; contractor; EDP Code) ^b	Average operating flow rate, ^c ft ³ /min (m ³ /s)	Volume, ft ³ (m ³)	Radionuclide or type of radioactivity	Average operating concentration, ^d μ Ci/mL	Emissions, Ci	EDE to MEI, ^e mrem
437-MN&ST (MASE: CHPRC: F014)	13,853 (6.54)	7.3 E+09 (2.1 E+08)	gross α	≤ 0	0	0
			gross β	2.0 E-15	6.3 E-07	8.2 E-08
437-MN&ST total dose: 8.2 E-08						
FFTF-CB-EX (FFTF: CHPRC: F011)	NA	NA	³ H (HTO)	NA	4.7 E-04	6.6 E-09
			gross α	NA	2.3 E-15	1.2 E-14
[Note: No measured flow from stack. Ci values derive from residual radioactive inventory in FFTF reactor primary piping systems, not actually measured from emission samples.]			gross β	NA	3.6 E-10	4.7 E-11
FFTF-CB-EX total dose: 6.6 E-09						
FFTF-HT-TR (FFTF: CHPRC: F013) did not operate; permanently shutdown						
FFTF-RE-SB (FFTF: CHPRC: F012) did not operate; permanently shutdown						
600 Area Minor Point Sources						
696-W-1 (WSCF: MSA/FIE: W010)	47,418 (22.38)	2.5 E+10 (7.1 E+08)	gross α	≤ 0	0	0
			gross β	≤ 0	0	0
696-W-1 total dose: 0						
696-W-2 (WSCF: MSA/FIE: W011)	1,178 (0.56)	6.2 E+08 (1.8 E+07)	gross α	≤ 0	0	0
			gross β	1.0 E-16	2.5 E-09	9.3 E-11
696-W-2 total dose: 9.3 E-11						

General definitions: ≤ 0 = analytical result equal to level of laboratory ambient background radioactivity or less than that level, which in practical terms means the radionuclide or type of radioactivity was not detected in the sample of the emission collected; Ci = curie; 1 Ci = 3.7 E+10 becquerels (Bq); ft³ = cubic feet; HT is tritium, or elemental tritium, in the form of an incondensable gas; HTO is tritiated water vapor, or tritium in the form of condensable water vapor; m³ = cubic meters; min = minute; mrem = millirem; NA = not applicable; NM = not measured; s = second; yr = year.

^a Determining the potential prospective dose impact of each point source necessitated using nearest public receptors, who may differ from the annually determined Hanford Site MEI.

^b Abbreviations and acronyms in this column are: CERCLA = Comprehensive Environmental Response, Conservation, and Liability Act of 1980; CHPRC = CH2M HILL Plateau Remediation Company; EDP code = electronic data processing code, used in chain-of-custody activities to identify sampling locations; FFTF = Fast Flux Test Facility; FH = Fluor Hanford, Inc.; MASF = Maintenance and Storage Facility; PNNL = Pacific Northwest National Laboratory; PFP = Plutonium Finishing Plant; TF = Tanks Farms; WCH = Washington Closure Hanford, LLC; WRPS = Washington River Protection Solutions, LLC; and WSCF = Waste Sampling and Characterization Facility.

^c Reflects stack flow rate averaged over time of stack operation.

^d Reflects concentration averaged over time of stack operation.

^e EDE for MEI = effective dose equivalent for the maximally exposed individual; for calendar year 2009, the MEI was located near Sagemoor Road, Franklin County, directly across the Columbia River from the Hanford Site 300 Area.

^f Emissions from this point source are associated with cleanup operations conducted under the authority of CERCLA. Reporting those emissions in Table 2-2 demonstrates compliance with the monitoring requirements of 40 CFR 61, Subpart H, which is a substantive equivalent law (i.e., "applicable, relevant, or appropriate requirement") as defined by CERCLA.

^g Value based on release records.

Table 2-3. Hanford Site Major Stack Heights and Abatement Technology.

Stack	Discharge height, ft (m)	Abatement technology ^a
100 Area Major Point Sources		
105-KW Air Sparging Vent	48 (14.6)	HEPA (1)
296-K-142	90 (27.4)	HEPAs (4 and 1 two-stage), isolation dampers (4), backdraft dampers (4), fans (8), prefilter
200 East Area Major Point Sources		
291-A-1	200 (61)	HEPAs (2 in series), deep-bed fiberglass filter, fans (two in parallel)
296-A-42	55 (16.8)	HEPAs (2 in parallel), condenser, water chiller, HEME, cooling water pump, heater, HEGA, chiller pump, moisture separator, fan, evaporative tower
296-A-44	28.1 (8.6)	HEPAs (2 in series), deentrainer, heater, prefilter, fan
296-A-45	28.1 (8.6)	HEPAs (2 in series), deentrainer, heater, prefilter, fan
296-A-46	28.1 (8.6)	HEPAs (2 in series), deentrainer, heater, prefilter, fan
296-A-47	28.1 (8.6)	HEPAs (2 in series), deentrainer, heater, prefilter, fan
296-B-1	90 (27.4)	HEPAs (4 in 2 trains: 2 banks in each train), prefilters (2 trains, one bank in each train), fans (2)
296-B-10	75 (22.9)	HEPAs and prefilters (2 in series, 2 more HEPA in parallel), fan (2), demister, heater, impingement vanes
296-H-212	75 (22.9)	HEPAs (2 double stage in parallel), fans (2 in parallel)
296-P-31	32 (9.8)	HEPAs (8: 2 banks of 4 each), prefilters (4), fan
296-P-47	15 (4.6)	HEPAs (2 in series), heater, demister, prefilters, fan
296-P-48	15 (4.6)	HEPAs (2 in series), demister, heater, prefilter, fan
200 West Area Major Point Sources		
296-P-43	15 (4.6)	HEPAs (2 in series), prefilter, heater, fan, demister
296-P-44	15 (4.6)	HEPAs (2 in series), prefilter, heater, fan, demister
296-P-45	15 (4.6)	HEPAs (2 in series), prefilter, heater, fan, demister
296-S-21	38 (11.6)	HEPAs and fan (3 each in series for Hot Cells and one each for Lab Complex)
291-T-1	200 (61)	HEPAs (2 in series), prefilters, fan (2 in parallel)
296-W-4	47 (14.2)	HEPAs (redundant system of 2 banks in parallel), prefilters, fan (4)
291-Z-1	200 (61)	HEPAs and fans (multiple parallel banks of each)
296-Z-7	50 (15.2)	HEPAs (2 in 2-stage in parallel banks), fan (2 in parallel)
300 Area Major Point Sources		
EP-324-01-S	150 (46)	HEPA, fan
EP-325-01-S	89 (27.1)	HEPAs (2 in series), fans (4 in parallel: 3 operational, one as backup)
EP-327-01-S	42.8 (13.1)	HEPA, fan
EP-331-01-V	62 (18.9)	HEPAs (2), fans (3 in parallel: 1 operational, 2 as backup)

^a The operational efficiency of HEPA filters is $\geq 99.95\%$; sand filter efficiency is $\geq 98\%$. The operational efficiencies of the other abatement technology are not known with certitude.

Table 2-4. Hanford Site Minor Stack Heights and Abatement Technology.

Stack	Discharge height, ft (m)	Abatement technology ^a
100 Area Minor Point Sources		
105-KW Basin	42 (12.8)	none
107-N	27.0 (8.2)	HEPA, fan
200 East Area Minor Point Sources		
296-A-18	12.5 (3.8)	HEPAs (2 in series), fan, heater
296-A-19	12.9 (3.9)	HEPAs (2 in series), fan, heater
296-A-21	22 (6.7)	HEPAs (2 in parallel), prefilters, fan
296-A-22	61 (18.6)	HEPAs (2 in series), heater, fan, prefilters, deentrainer
296-A-20	15.7 (4.8)	HEPAs (2 in series, one series for each of 2 trains), fan, radial damper, heater
296-A-26	27 (8.2)	HEPAs (2), fan, deentrainers (2), heater
296-A-28	23 (7.0)	HEPAs (2 in series), fan, deentrainer, heater
296-A-30	23 (7.0)	HEPAs (2), deentrainer, heater, fan
296-A-40	13.3 (4.1)	HEPAs (2 in series in parallel paths), deentrainer, heater, prefilters, fan
296-A-41	29.2 (8.9)	HEPAs (2 in series in parallel paths), heater, fan
296-A-43	35.5 (10.8)	HEPA, prefilter, fan, isolation damper
296-E-1	51 (15.5)	HEPAs and fans (5 and 3, in different configurations, respectively)
200 West Area Minor Point Sources		
296-P-22	10.2 (3.1)	HEPAs (2 in series), fan
296-P-23	15 (4.6)	HEPAs (2 in series), deentrainer, prefilters, fan
296-S-15	15 (4.6)	HEPA, prefilter, fan — all in one flow path
296-S-18	22 (6.7)	HEPAs (2 in parallel with 2 in series), fan
296-S-23	21.5 (6.6)	HEPAs (2 in series), prefilter, fan
296-S-25	15 (4.6)	HEPAs (2 in series), deentrainer, heater, prefilter, fan
296-T-17	32 (9.8)	HEPAs (4 units with 2 in series in parallel paths), fan
291-S-1	200 (61)	sand filter, fans (2 in parallel)
296-S-16	9.8 (3)	HEPA, fan
296-T-7	28 (8.5)	HEPA, demister, heater, prefilter, fan
291-U-1	200 (61)	sand filter, fan (2 in parallel)
296-Z-5	28 (8.5)	HEPAs (2 in parallel), fan (up to 4)
296-Z-6	15 (4.5)	HEPAs and fans (2 each in parallel)
296-Z-15	42 (12.8)	HEPA, fan
300 Area Minor Point Sources		
340-DECON	27 (8.2)	HEPAs (2 in series), prefilters (3 in parallel) fan, moisture separator
340-NT-EX	18 (5.5)	HEPAs (2 in series), prefilter, fans (2 in parallel), moisture separator
EP-318-01-S	29 (8.8)	HEPA, exhaust fan
EP-320-01-S	40 (12.1)	HEPAs (2 in series), fans (2 in parallel: 1 operational, 1 as backup)
EP-320-02-S	32 (9.7)	HEPAs (2 in series), fan
EP-326-01-S	47.6 (14.5)	HEPAs (2 in series for Secondary Electron Multiplier, otherwise 1); fans (3 in parallel)
EP-329-01-S	62.6 (19.1)	HEPAs (2 in series), fans (3 in parallel: 2 operational, 1 as backup)
400 Area Minor Point Sources		
437-1-61	38.4 (11.7)	HEPAs and prefilters (ambiguous description of quantity), fan
437-MN&ST	30 (9.1)	HEPA (at least 4 in different configurations, fans (2), prefilters (3))
600 Area Minor Point Sources		
696-W-1	25 (7.6)	HEPA (2 in parallel), prefilters (2 in parallel), fans (2 in parallel)
696-W-2	32 (9.8)	HEPA (2 in parallel), prefilters (2 in parallel), fan, and a standby fan

^a The operational efficiency of HEPA filters is $\geq 99.95\%$; sand filter efficiency is $\geq 98\%$. The operational efficiencies of the other abatement technology are not known with certitude.

Table 2-5. Distances and Directions from Hanford Site Operational Areas to Receptors at Respective Nearest Residences and Farms^a

Receptor		Distance (km [mi]) and direction from Hanford Site operational area ^b				
		100 Area	200 East Area	200 West Area	300 Area	400 Area
Offsite residence	Hanford Site MEI ^c	40.6 (25.2) SE	28.3 (17.6) SE	35.1 (21.8) SE	1.4 (0.87) E	10.8 (6.7) SE
	Nearest	8.9 (5.6) NNW	21.2 (13.2) E	13.7 (8.5) W	1.4 (0.87) E	8.6 (5.5) E
	Nearest in prevailing wind	24.2 (15.1) E	21.6 (13.5) ESE	22.0 (13.8) SE	1.4 (0.87) NE	9.1 (5.7) SE
Onsite public receptor	Nearest ^d	26.1 (16.2) SE	13.5 (8.4) SE	20.2 (12.6) ESE	12.3 (7.6) NNW	4.3 (2.7) WNW
	Nearest in prevailing wind	26.1 (16.2) SE	16.7 (10.4) ESE	20.2 (12.6) ESE	14.0 (8.8) NW	4.4 (2.7) NNE
Vegetable-producing farm	Nearest	9.8 (6.1) NW	21.1 (13.1) E	17.7 (11.0) NW	3.2 (2.0) E	10.5 (6.5) ESE
	Nearest in prevailing wind	24.9 (15.5) E	21.1 (13.1) E	29.9 (18.6) SE	4.0 (2.5) NE	12.6 (7.8) SE
Milk-producing farm	Nearest	34.9 (21.7) E	29.1 (18.1) ENE	34.6 (21.5) S	5.8 (3.6) ESE	13.5 (8.3) E
	Nearest in prevailing wind	34.9 (21.7) E	30.6 (19.0) ESE	38.9 (24.2) ESE	9.2 (5.7) NE	15.3 (9.5) SE
Meat-producing farm	Nearest	11.2 (7.0) NNW	20.9 (13.0) WNW	17.7 (11.0) WSW	2.7 (1.7) ESE	12.2 (7.6) SE
	Nearest in prevailing wind	31.4 (19.5) ESE	24.0 (14.9) E	27.0 (16.8) SE	8.0 (5.0) NE	12.2 (7.6) SE

^a The definition of residence includes dwelling, school, business, or office.

^b All emission points within an emission Area are assigned a single distance to the nearest receptor; km = kilometer; mi = mile.

^c A member of the public who lives at a residence near Sagemoor Road, in Franklin County, directly across the Columbia River from the Hanford Site 300 Area.

^d The nearest onsite receptor is employed at the Laser Interferometer Gravitational Wave Observatory (LIGO). This receptor, who from year to year could be but is not necessarily the MEI, is a member of the public not employed by DOE or its contractors and who works on the Hanford Site at a location to which access is not controlled by DOE. For radiological dose impacts from emissions in 2009, numerous offsite public receptors and onsite public receptors were evaluated. The evaluations determined that an offsite receptor near Sagemoor Road, in Franklin County, received the maximum dose due to air emissions from all Hanford Site sources during 2009. For onsite receptors, two employment locations were evaluated: LIGO and ENCGS.

3.0 POINT SOURCE EMISSION DOSE ASSESSMENTS

3.1 DESCRIPTION OF POINT SOURCE EMISSIONS DOSE MODEL

The year 1990 was the first year this annual report format was required to comply with the Clean Air Act Amendments of 1990, described earlier in 54 Federal Register 16965, December 15, 1989. For 2009, CAP88-PC Version 3 was used to determine the compliance status of Hanford Site radionuclide air emissions with the 10 mrem/yr EDE standard of both 40 CFR 61 Subpart H and of WAC 246-247. Doses from 1990 through 1992 were modeled using the Clean Air Act Assessment Package-1988 (CAP-88), an early mainframe version of the program. Doses from 1993 through 2006 were modeled using CAP88-PC Version 1 (EPA 1992, Clean Air Act Assessment Package – 1988, for Personal Computer), a desktop computer version of CAP-88 that relies more on default parameters than does the mainframe version.

Because the Hanford Site has numerous and widely separated emission points, it is necessary to determine the point at which the maximum dose would be received from the combined air emissions released from all locations. To model the doses from those emissions, each of the five major operational areas is assigned within it a single reference facility having an emission point that typically is the source of maximum emissions from that Area to the Hanford Site MEI. The straight-line distances and directions to the MEI from each of the five reference facilities are used in the dose calculations, which include annual meteorological data (refer to Appendix A). In 2009, those reference facilities were the 105-KE Building in the 100 Areas; the PUREX Facility in the 200 East Area; PFP in the 200 West Area; the 325 Building in the 300 Area; and FFTF in the 400 Area.

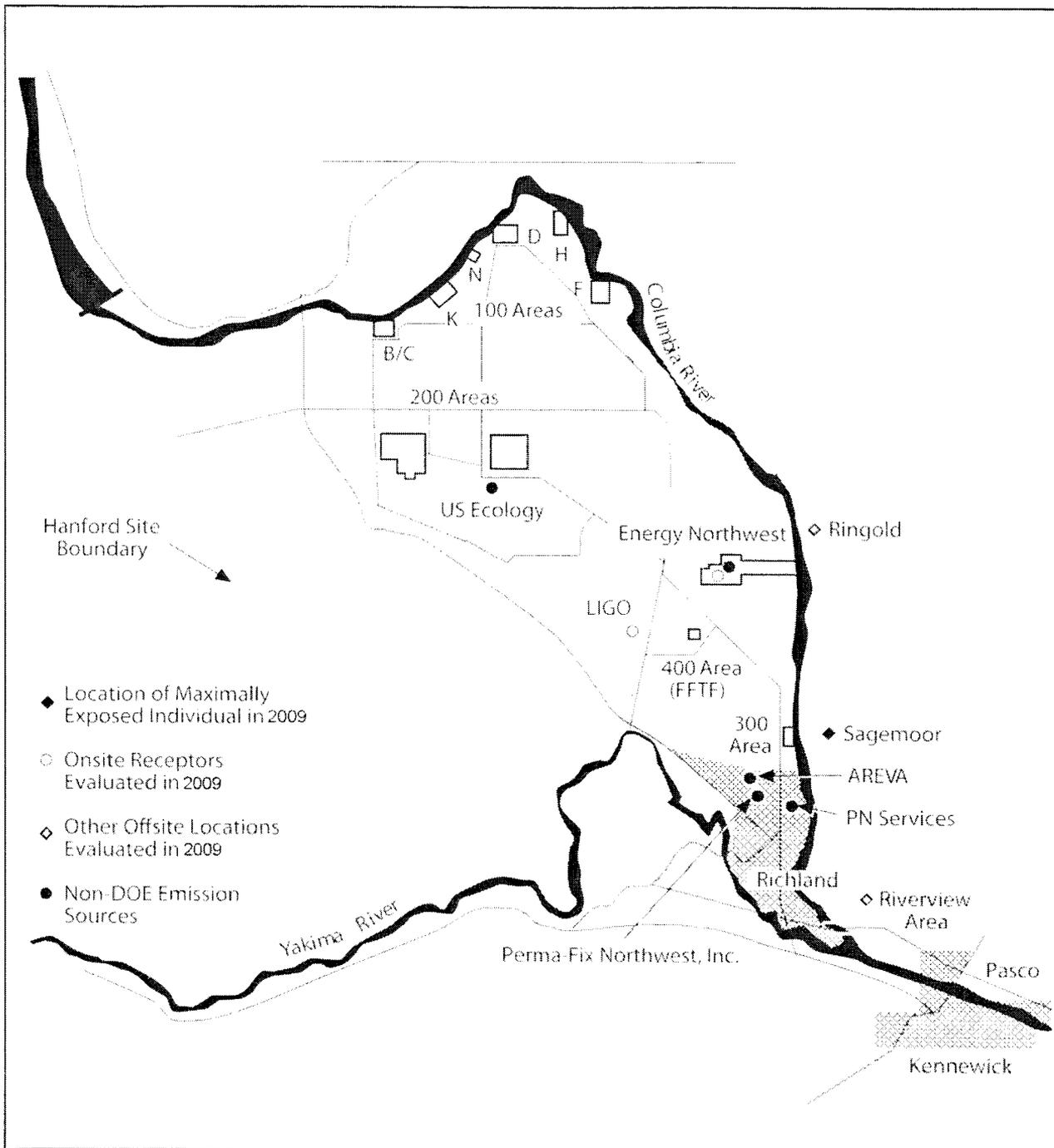
For reports from 1990 through 1999, only offsite members of the public had been evaluated for dose. During this period, the annual MEI resided at these locations: from 1990 through 1992, Ringold, in Franklin County, east-southeast of the 200 Areas and northeast of the 300 Area; from 1993 through 1999, near Sagemoor Road, directly east and across the Columbia River from the 300 Area. Starting with the report for 2000, a new category of members of the public was evaluated in determining the MEI: non-DOE employees at work locations within the Hanford Site boundary. Private-sector reindustrialization at the Hanford Site forced a broadening of the MEI definition to include members of the public not employed by DOE and whose workplace is within the boundaries of the Hanford Site yet outside DOE-controlled areas. Under this new definition, the MEI location for 2000 shifted from what would have been the offsite residence near Sagemoor Road to a Washington State University (WSU) laboratory in the 300 Area, north of Richland. In 2001, the location changed to the 313 Building, also in the 300 Area. In early 2002, non-DOE employment at the WSU laboratory and the 313 Building ceased, causing the MEI to shift back to the offsite Sagemoor Road location in 2002 and 2003. For 2004, the MEI location shifted to Ringold, owing mainly to reduced point source emissions of ^3H from the 300 Area. For 2005, the MEI location returned to the Sagemoor Road residence, where it has remained through 2009 due to consistently higher point source emissions of ^3H from the 300 Area.

The principal locations evaluated for the MEI are shown in Figure 3-1. Figure 3-2 displays the MEI doses attributable to radionuclide emissions from Hanford Site point sources from 1990 through 2009.

3.2 SUMMARY OF INPUT PARAMETERS

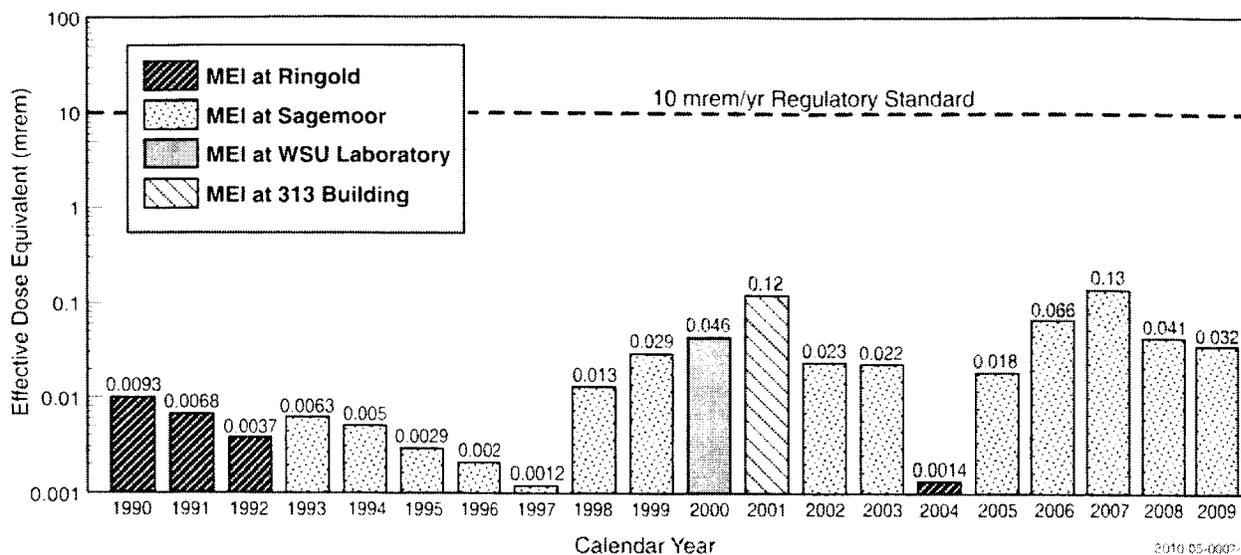
Dose calculations were performed using established standard parameters for the Hanford Site and its environment (refer to DOE/RL-2007-53, *Methods for Calculating Doses to Demonstrate Compliance with Air Pathway Radiation Dose Standards at the Hanford Site*). Point source emissions data by radionuclide and operational area (refer to Table 3-1) were used in the dose calculations. The calculations

Figure 3-1. Locations of Hanford Site Maximally Exposed Individual and Other Evaluated Receptor Locations for 2009.



G07040018.96

Figure 3-2. Doses to the Maximally Exposed Individual Due to Point Source Emissions of Radionuclides from the Hanford Site, 1990 through 2009.



used an effective discharge height of 33 ft (10 m) for all release locations other than the 200 Area facilities, which were assumed to have an effective release height of 292 ft (89 m; DOE/RL-2006-29, *Calculating Potential-to-Emit Radiological Releases and Doses*). In all but one case, emissions reported as gross alpha or gross beta were evaluated as $^{239/240}\text{Pu}$ or ^{90}Sr , respectively. The one exception is for gross beta emissions from the 400 Area where, based on facility-specific information, those emissions were modeled as ^{137}Cs .

Additional data used for dose calculations are in Appendix A; all other radionuclide-specific parameters used were default values in CAP88-PC data libraries. Maximum individual exposure and consumption parameters were those determined previously for the Hanford Site. The entire hypothetical MEI diet was constructed using the "local" food production option in CAP88-PC for ingestion-pathway parameters. For locations within the Hanford Site boundary, the ingestion dose was estimated using average individual parameters for the 80-km (50-mi) assessment area. Radionuclide air concentrations at receptor locations were determined using site-specific meteorological data for each representative release location. Joint-frequency distributions and CAP88-PC wind files were prepared from data collected at weather stations in each of the operational areas and represent the average of hourly data taken during 2009.

3.3 COMPLIANCE ASSESSMENT

3.3.1 40 Code of Federal Regulations 61, Subpart H, Regulatory Standard

The regulatory standard for a maximum dose to any member of the public is 10 mrem/yr EDE. The standard is in 40 CFR 61, Subpart H, and applies to radionuclide air emissions, other than radon, from DOE facilities. For calendar year 2009, the Hanford Site MEI location was near Sagemoor Road, Franklin County, Washington, directly east of the 300 Area. The combined dose to the MEI from routine and nonroutine Hanford Site point source emissions was 0.032 mrem (0.00032 mSv) EDE. The majority of that dose (i.e., ≈ 99 percent) is attributable to ^3H point source emissions from the 300 Area (refer to Table 3-2).

Table 3-1. Hanford Site Radionuclide Air Emissions from Point Sources in 2009. (2 sheets)

Radionuclide	Releases, Ci ^a					
	100 Areas	200 East Area	200 West Area	300 Area	400 Area	Total
³ H (as HT) ^b	NM	NM	NM	2.7 E+01	NM	2.7 E+01
³ H (as HTO) ^c	NM	NM	NM	1.3 E+02	4.7 E-04	1.3 E+02
¹⁴ C	NM	NM	NM	5.0 E-05 ^d	NM	5.0 E-05 ^d
⁶⁰ Co	ND	ND	ND	3.5 E-08 ^e	NM	3.5 E-08 ^e
⁸⁵ Kr	NM	NM	NM	2.4 E-02 ^d	NM	2.4 E-02 ^d
⁹⁰ Sr	1.0 E-04 ^f	5.1 E-04 ^g	2.1 E-05 ^h	8.3 E-06 ⁱ	NM	6.4 E-04 ^j
⁹⁰ Y	NA	NA	NA	1.1 E-04 ^e	NA	1.1 E-04 ^e
⁹⁹ Tc	NM	NM	NM	4.0 E-06 ^e	NM	4.0 E-06 ^e
¹⁰⁶ Ru	ND	ND	3.2 E-07	ND	NM	3.2 E-07
¹²⁹ I	NM	1.5 E-03	NM	NM	NM	1.5 E-03
^{131m} Xe	NM	NM	NM	5.1 E-09 ^d	NM	5.1 E-09 ^d
¹³³ Xe	NM	NM	NM	1.4 E-07 ^d	NM	1.4 E-07 ^d
^{137m} Ba	NA	NA	NA	3.0 E-06 ^e	NA	3.0 E-06 ^e
¹³⁷ Cs	2.6 E-05	5.9 E-05	1.1 E-05	7.2 E-07	9.9 E-07 ^h	9.8 E-05
¹⁵¹ Sm	NM	NM	NM	1.7 E-06 ^e	NM	1.7 E-06 ^e
¹⁵⁴ Eu	2.3 E-07	ND	ND	5.2 E-07 ^e	NM	7.5 E-07 ^e
¹⁵⁵ Eu	ND	ND	ND	5.0 E-08 ^e	NM	5.0 E-08 ^e
¹⁸⁵ Ta	NM	NM	NM	1.6 E-19 ^e	NM	1.6 E-19 ^e
¹⁸⁸ W	NM	NM	NM	3.2 E-13 ^e	NM	3.2 E-13 ^e
²²⁰ Rn	NM	NM	NM	5.4 E+01 ^g	NM	5.4 E+01 ^g
²²² Rn	NM	NM	NM	7.0 E-01 ^g	NM	7.0 E-01 ^g
²²⁸ Th	NM	NM	NM	1.8 E-10 ^e	NM	1.8 E-10 ^e
²³² Th	NM	NM	NM	1.0 E-10 ^e	NM	1.0 E-10 ^e
²³² U	NM	NM	NM	5.1 E-09 ^e	NM	5.1 E-09 ^e
²³³ U	NM	NM	NM	2.4 E-08 ^e	NM	2.4 E-08 ^e
²³⁴ U	NM	NM	3.5 E-08	6.0 E-10 ^e	NM	3.6 E-08 ^e
²³⁵ U	NM	NM	2.2 E-09	5.4 E-11 ^e	NM	2.3 E-09 ^e
²³⁶ U	NM	NM	NM	2.3 E-11 ^e	NM	2.3 E-11 ^e
²³⁷ Np	NM	NM	NM	1.3 E-07 ^e	NM	1.3 E-07 ^e
²³⁸ U	NM	NM	3.4 E-08	1.1 E-08 ^e	NM	4.5 E-08 ^e
²³⁸ Pu	1.5 E-06	ND	ND	1.7 E-08	NM	1.5 E-06
^{239,240} Pu	3.2 E-05 ^l	3.0 E-06 ^l	2.9 E-05 ^l	5.1 E-07 ^l	2.3 E-15 ^l	6.4 E-05 ^l
²⁴¹ Pu	2.1 E-05	ND	5.2 E-06	ND	NM	2.6 E-05

Table 3-1. Hanford Site Radionuclide Air Emissions from Point Sources in 2009. (2 sheets)

Radionuclide	Releases, Ci ^a					
	100 Areas	200 East Area	200 West Area	300 Area	400 Area	Total
²⁴² Pu	NM	NM	NM	2.4 E 10 ^c	NM	2.4 E 10 ^c
²⁴¹ Am	8.5 E 06	2.1 E 07	2.3 E-06	4.8 E 08	NM	1.1 E-05
²⁴³ Am	NM	NM	NM	1.2 E 07 ^c	NM	1.2 E 07 ^c
^{243/244} Cm	NM	NM	NM	ND	NM	ND
²⁵² Cf	NM	NM	NM	5.0 E 14 ^c	NM	5.0 E 14 ^c

^a 1 Ci = 1 curie = 3.7 E+10 becquerels (Bq); ND = not detected (i.e., either the radionuclide was not detected in any sample during the year or the average of all the measurements for that given radionuclide or type of radioactivity made during the year was below background levels); NM = not measured.

^b HT = tritium in the form of incondensable gas.

^c HTO = tritium in the form of condensable water vapor.

^d Release based on release records.

^e Calculated release based on Appendix D method of 40 CFR 61.

^f This release value includes data on gross beta emissions from some stacks.

^g Radon release value conservatively calculated, not actually measured.

^h This release value derives entirely from data on gross beta emissions from 400 Area stacks.

ⁱ This release value includes data on gross alpha emissions from some stacks, except for those in the 400 Area, the value for which derives entirely from calculations of residual radioactive material in the FFTF reactor primary piping systems.

Table 3-2. CAP88-PC Effective Dose Equivalent Estimates for the Maximally Exposed Individual at Sagemoor Road, Resulting from Hanford Site Point Source Radionuclide Air Emissions in 2009.
(2 sheets)

Radionuclide	Distances, directions, and effective dose equivalent (mrem) to offsite MEI, by radionuclide and operational area ^a					EDE (40 CFR 61, Subpart H) by radionuclide	
	100 Area 41 km SE	200 East Area 28 km SE	200 West Area 35 km SE	300 Area 1.4 km E	400 Area 11 km SE	EDE Total (mrem)	Percent of EDE Total
³ H (HT)	NM	NM	NM	2.7 E 03	NM	2.7 E 03	8.594
³ H (HTO)	NM	NM	NM	2.9 E 02	1.5 E 08	2.9 E 02	90.177
¹⁴ C	NM	NM	NM	5.3 E 07 ^b	NM	5.3 E 07	0.002
⁶⁰ Co	ND	ND	ND	1.3 E 08 ^b	NM	1.3 E 08 ^b	<0.001
⁸⁵ Kr	NM	NM	NM	1.9 E 08	NM	1.9 E 08	<0.001
⁹⁰ Sr	2.4 E 06 ^c	1.7 E 05 ^c	7.9 E 07 ^c	1.6 E 05 ^c	NM	3.6 E 05 ^c	0.114
⁹⁰ Y	NA	NA	NA	1.5 E 07 ^b	NA	1.5 E 07 ^b	<0.001
⁹⁹ Tc	NM	NM	NM	1.4 E 06 ^b	NM	1.4 E 06 ^b	0.004
¹⁰⁶ Ru	ND	ND	4.9 E 10	ND	NM	4.9 E 10	<0.001
¹²⁹ I	NM	1.8 E 04	NM	NM	NM	1.8 E 04	0.569
^{131m} Xe	NM	NM	NM	5.8 E 15	NM	5.8 E 15	<0.001
¹³³ Xe	NM	NM	NM	5.9 E 13	NM	5.9 E 13	<0.001
^{137m} Ba	NA	NA	NA	2.6 E 11 ^b	NA	2.6 E 11 ^b	<0.001
¹³⁷ Cs	3.4 E 07	1.1 E 06	2.3 E 07	7.5 E 07	1.3 E 07 ^d	2.6 E 06 ^c	0.008
¹⁵¹ Sm	NM	NM	NM	6.2 E 09 ^b	NM	6.2 E 09 ^b	<0.001
¹⁵⁴ Eu	4.0 E 10	ND	ND	7.5 E 08 ^b	NM	7.6 E 08 ^b	<0.001
¹⁵⁵ Eu	ND	ND	ND	5.5 E 10 ^b	NM	5.5 E 10 ^b	<0.001
¹⁸³ Ta	NM	NM	NM	4.0 E 22 ^b	NM	4.0 E 22 ^b	<0.001
¹⁸⁸ W	NM	NM	NM	4.2 E 14 ^b	NM	4.2 E 14 ^b	<0.001
²²⁸ Th	NM	NM	NM	5.8 E 09 ^b	NM	5.8 E 09 ^b	<0.001
²³² Th	NM	NM	NM	2.1 E 09 ^b	NM	2.1 E 09 ^b	<0.001
²³² U	NM	NM	NM	3.9 E 08 ^b	NM	3.9 E 08 ^b	<0.001
²³³ U	NM	NM	NM	7.5 E 08 ^b	NM	7.5 E 08 ^b	<0.001
²³⁴ U	NM	NM	1.7 E 09	1.8 E 09 ^b	NM	3.5 E 09	<0.001
²³⁵ U	NM	NM	9.6 E 11	1.5 E 10 ^b	NM	2.4 E 10	<0.001
²³⁶ U	NM	NM	NM	6.4 E 11 ^b	NM	6.4 E 11 ^b	<0.001
²³⁷ Np	NM	NM	NM	2.4 E 06 ^b	NM	2.4 E 06 ^b	0.008
²³⁸ U	NM	NM	1.4 E 09	2.9 E 08 ^b	NM	3.0 E 08	<0.001
²³⁸ Pu	6.5 E 07	ND	ND	6.7 E 07	NM	1.3 E 06	0.004
^{239,240} Pu	1.5 E 05 ^f	1.8 E 06 ^f	1.9 E 05 ^f	2.2 E 05 ^f	1.2 E 14 ^g	5.8 E 05 ^h	0.181

Table 3-2. CAP88-PC Effective Dose Equivalent Estimates for the Maximally Exposed Individual at Sagemoor Road, Resulting from Hanford Site Point Source Radionuclide Air Emissions in 2009.
(2 sheets)

Distances, directions, and effective dose equivalent (mrem) to offsite MEI, by radionuclide and operational area ^a						EDE (40 CFR 61, Subpart H) by radionuclide	
Radionuclide	100 Area	200 East Area	200 West Area	300 Area	400 Area	EDE Total (mrem)	Percent of EDE Total
	41 km SE	28 km SE	35 km SE	1.4 km E	11 km SE		
²⁴¹ Pu	1.8 E-07	ND	6.2 E-08	ND	NM	2.4 E-07	0.001
²⁴² Pu	NM	NM	NM	9.7 E-05 ^b	NM	9.7 E-05 ^b	0.304
²⁴¹ Am	3.3 E-06	1.1 E-07	1.3 E-06	1.7 E-06	NM	6.4 E-06	0.020
²⁴³ Am	NM	NM	NM	4.2 E-06 ^b	NM	4.2 E-06 ^b	0.013
^{243/244} Cm	NM	NM	NM	ND	NM	0	0.000
²⁵² Cf ^d	NM	NM	NM	1.4 E-12 ^b	NM	1.4 E-12 ^b	<0.001
Dose totals	2.2 E-05	2.0 E-04	2.1 E-05	3.2 E-02	1.4 E-07	3.2 E-02^j	▼
Percent of total dose	0.069	0.633	0.067	99.231	<0.001	► Percent total: 100	

^a 1 mrem = 0.01 mSv; 1 km = 0.621 mi.

^b This dose estimate derives entirely from 40 CFR 61 Appendix D estimated emissions.

^c This dose estimate includes data on emissions of gross beta, assumed to be ⁹⁰Sr in dose calculations.

^d This dose estimate derives entirely from data on FFTF emissions of gross beta, assumed to be ¹³⁷Cs in dose calculations.

^e This dose estimate derives from a combination of actual emission measurements of ¹³⁷Cs and from measurements of FFTF emissions of gross beta assumed to be ¹³⁷Cs in dose calculations.

^f This dose estimate includes data on emissions of gross alpha, assumed to be ^{239/240}Pu in dose calculations for some stacks.

^g This dose estimate derives entirely from emission estimates based on the residual inventory of radioactive material in the FFTF reactor primary piping systems.

^h This dose estimate includes data on emissions of ^{239/240}Pu, on gross alpha assumed to be ^{239/240}Pu in dose calculations for some stacks, and from emission estimates based on the residual inventory of radioactive material in the FFTF reactor primary piping systems.

ⁱ The surrogate nuclide ²⁵⁰Cf was used to determine the dose from ²⁵²Cf (PNNL-17847, Rev. 1, *PNNL Site Dose-per-Unit-Release Factors for Use in Calculating Radionuclide Air Emissions Potential-to-Emit Doses*).

^j The particulate radionuclide portion of the total point source dose is 2.1 E-04 mrem, or 0.66% of the total.

Next, Table 3-3 shows the contribution to the MEI dose in 2009 from each major stack, grouped by operational area. Table 3-4 ranks each stack by the dose attributable to its emissions compared to the Hanford Site MEI dose for calendar year 2009 of 0.032 mrem (0.00032 mSv) EDE from all point source emissions.

Table 3-3. Doses from Hanford Site Major Point Sources that Operated in 2009.

Source identification (contractor)	Effective dose equivalent (mrem) ^a	Percent of dose total ^b
100-K West Area		
296-K-142 (CHPRC)	2.4 E 08	0.00008
200 East Area		
291-A-1 (CHPRC)	1.8 E 04	0.56250
296-A-42 (WRPS)	6.6 E 10	<0.00001
296-A-44 and 296-A-45 (WRPS)	5.5 E 09	0.00002
296-A-46 and 296-A-47 (WRPS)	5.2 E 09	0.00002
296-B-1 (CHPRC)	9.8 E 08	0.00031
296-B-10 (CHPRC)	1.9 E 05	0.05938
296-H-212 (CHPRC)	4.1 E 08	0.00013
296-P-31 (CHPRC)	1.7 E 08	0.00005
296-P-45 (WRPS)	DNO	NA
296-P-47 (WRPS)	DNO	NA
296-P-48 (WRPS)	1.5 E 09	<0.00001
200 West Area		
291-T-1 (CHPRC)	1.4 E 06	0.00438
291-Z-1 (CHPRC)	2.0 E 05	0.06250
296-P-43 (WRPS)	DNO	NA
296-P-44 (WRPS)	1.5 E 08	0.00005
296-S-21 (WRPS)	9.8 E 08	0.00031
296-W-4 (CHPRC)	1.4 E 08	0.00004
296-Z-7 (CHPRC)	1.6 E 09	<0.00001
300 Area		
EP-324-01-S (WCH)	8.2 E 07	0.03150
EP-325-01-S (PNNL)	3.1490 E 02 ^c	98.77063
EP-327-01-S (WCH)	7.4 E 06	0.01163
EP-331-01-V (PNNL)	8.9 E 06	0.0017
Major point source totals ►	≈3.2 E-02	≈99.9

^a 1 mrem = 1.0 E-02 mSv

^b Of the ≈3.2 E 02 mrem total for all stacks, the portion from minor stacks is ≈5.2 E 05 mrem, or ≈0.16%. Slightly varying totals are due to numerical rounding.

^c Additional decimal places displayed because this is the dominant dose.

DNO = did not operate; NA = not applicable

Table 3-4. Ranking of Doses from Hanford Site Stack Radionuclides Emissions
by Stack, Calendar Year 2009. (2 sheets)

Rank	Stack	Major or minor	Contractor	Operating Area	EDE (mrem/yr) ^a	Percent of total dose
1	EP-325-01-S	Major	PNNL	300	0.031490	98.77063
2	291-A-1	Major	CHPRC	200 East	1.8 E-04	0.56250
3	EP-326-01-S	minor	PNNL	300	2.6 E-05	0.08125
4	105-KW Basin	minor	CHPRC	100-KW	2.2 E-05	0.06875
5	291-Z-1	Major	CHPRC	200 West	2.0 E-05	0.06250
6	296-B-10	Major	CHPRC	200 East	1.9 E-05	0.05938
7	EP-331-01-V	Major	PNNL	300	8.9 E-06	0.02781
8	EP-327-01-S	Major	WCH	300	7.4 E-06	0.02313
9	EP-320-01-S	minor	PNNL	300	1.8 E-06	0.00563
10	291-T-1	Major	CHPRC	200 West	1.4 E-06	0.00438
11	EP-324-01-S	Major	WCH	300	8.2 E-07	0.00256
12	291-U-1	minor	CHPRC	200 West	7.0 E-07	0.00219
13	EP-329-01-S	minor	PNNL	300	5.7 E-07	0.00178
14	296-E-1	minor	CHPRC	200 East	1.6 E-07	0.00050
15	291-S-1	minor	CHPRC	200 West	1.5 E-07	0.00047
16	340-DECON	minor	CHPRC	300	1.4 E-07	0.00044
17	296-S-21	Major	WRPS	200 West	9.8 E-08	0.00031
17	296-B-1	Major	CHPRC	200 East	9.8 E-08	0.00031
19	296-A-28	minor	WRPS	200 East	8.8 E-08	0.00028
20	437-MN&ST	minor	CHPRC	400	8.2 E-08	0.00026
21	296-A-21	minor	WRPS	200 East	6.4 E-08	0.00020
22	296-A-41	minor	WRPS	200 East	4.8 E-08	0.00015
23	437-1-61	minor	CHPRC	400	4.7 E-08	0.00015
24	296-H-212	Major	CHPRC	200 East	4.1 E-08	0.00013
25	296-A-30	minor	WRPS	200 East	3.4 E-08	0.00011
26	296-Z-6	minor	CHPRC	200 West	3.0 E-08	0.00009
27	296-K-142	Major	CHPRC	100-K	2.4 E-08	0.00008
28	296-A-43	minor	WRPS	200 East	1.8 E-08	0.00006
29	EP-320-02-S	minor	PNNL	300	1.7 E-08	0.00005
29	296-P-31	Major	CHPRC	200 East	1.7 E-08	0.00005
31	340-NT-EX	Major	CHPRC	300	1.6 E-08	0.00005
32	296-P-44	Major	WRPS	200 West	1.5 E-08	0.00005
33	296-W-4	Major	CHPRC	200 West	1.4 E-08	0.00004
34	296-A-19	minor	WRPS	200 East	1.1 E-08	0.00003
35	EP-318-01-S	minor	PNNL	300	9.6 E-09	0.00003
35	296-A-18	minor	WRPS	200 East	9.6 E-09	0.00003
37	FFTF-CB-EX	minor	CHPRC	400	6.6 E-09	0.00002
37	296-S-18	minor	WRPS	200 West	6.6 E-09	0.00002
39	296-A-44, -45	Major	WRPS	200 East	5.5 E-09	0.00002
39	296-A-46, -47	Major	WRPS	200 East	5.2 E-09	0.00002
41	296-A-40	minor	WRPS	200 East	4.6 E-09	0.00001
42	107-N	minor	WCH	100-N	4.1 E-09	0.00001

Table 3-4. Ranking of Doses from Hanford Site Stack Radionuclides Emissions
by Stack, Calendar Year 2009. (2 sheets)

Rank	Stack	Major or minor	Contractor	Operating Area	EDE (mrem/yr) ^a	Percent of total dose
43	296-S-25 & 296-P-23	minor	WRPS	200 West	3.8 E 09	0.00001
44	296-P-22	minor	WRPS	200 East	3.0 E 09	<0.00001
45	296-A-20	minor	WRPS	200 East	2.5 E 09	<0.00001
46	296-A-22	minor	WRPS	200 East	2.0 E 09	<0.00001
47	296-Z-7	Major	CHPRC	200 West	1.6 E 09	<0.00001
48	296-P-48	Major	WRPS	200 East	1.5 E 09	<0.00001
49	296-S-16	minor	WRPS	200 West	8.3 E 10	<0.00001
50	296-A-42	Major	WRPS	200 East	6.6 E 10	<0.00001
51	696-W-2	minor	MSA-FH	600	9.3 E 11	<0.00001
52	296-T-7	minor	CHPRC	200 West	0	0
52	296-Z-5	minor	CHPRC	200 West	0	0
52	296-Z-15	minor	CHPRC	200 West	0	0
52	696-W-1	minor	MSA-FH	600	0	0
NA	296-A-10	minor	CHPRC	200 East	DNO	NA
NA	296-A-26	minor	WRPS	200 East	DNO	NA
NA	296-P-43	Major	WRPS	200 West	DNO	NA
NA	296-P-45	Major	WRPS	200 East	DNO	NA
NA	296-P-47	Major	WRPS	200 East	DNO	NA
NA	296-W-3	minor	WRPS	200 West	DNO	NA
NA	296-T-17	minor	WRPS	200 West	DNO	NA
NA	296-S-15	minor	WRPS	200 West	DNO	NA
NA	340-B BLDG	minor	CHPRC	300	DNO	NA
NA	EP-320-04-S	minor	PNNL	300	DNO	NA
Totals^c ▶					≈3.2 E-02	≈100

^a EDE = effective dose equivalent; 1 mrem = 1.0 E-02 mSv

^b Extra decimal places are displayed for this stack because in comparison to all of stacks it comprises the largest percentage of the total dose.

^c Slight differences in totals due to rounding.

DNO = did not operate; NA = not applicable.

3.3.2 Washington Administrative Code 246-247

For Hanford Site radionuclide air emissions, Washington State in WAC 246-247-040(1) has adopted the federal dose standard of 10 mrem/yr EDE found in 40 CFR 61 Subpart H. In addition to the maximum dose attributable to radionuclides emitted from point sources, WAC 246-247-040(6) requires that the dose to the MEI also include doses attributable to fugitive emissions, radon (refer to Section 3.6.3), and to nonroutine events (refer to Section 3.5). Sampling data from ambient air samplers stationed at the perimeter of the Hanford Site were used to estimate emissions from fugitive sources. The reportable fugitive emission dose was calculated for the MEI near Sagemoor Road because that is the location of the MEI for emissions from point sources (refer to Section 4.0 for a further discussion on the basis for this). The MEI doses from the calculated releases of two radon isotopes are discussed in Section 3.6.3 and shown in Table 3-5; the release values are based on conservative engineering estimates. No known instances of significant nonroutine emissions occurred in 2009, and no nonsignificant nonroutine emission had any discernible contribution to the cumulative emissions from the Hanford Site. Thus, the total dose to the MEI in 2009 at the Sagemoor Road location from all Hanford Site radionuclide emissions, including routine emissions from point sources, fugitive sources, and radon, as well as nonroutine emissions was 0.067 mrem (0.00067 mSv) EDE. This total dose is the sum of doses from Hanford Site point sources (i.e., 0.032 mrem [0.00032 mSv] EDE), fugitive sources (i.e., 0.020 mrem [0.00020 mSv] EDE), and radon sources (i.e., 0.015 mrem [0.00015 mSv]).

3.4 METEOROLOGICAL DATA

Radionuclide air emissions disperse once they enter the atmosphere. Atmospheric dispersion models predict the degree of dilution and the magnitude of resulting air concentrations at downwind locations. Site-specific measurements of the occurrence frequencies for wind speed, wind direction, and atmospheric stability are used in the models. The dispersion models yield annual average dispersion factors, in units of seconds per cubic meter (s/m^3). Combining these factors with annual average release rates yields predictions of average radionuclide air concentrations for the year. Meteorological data for 2009 are presented in the appendix as joint frequency of wind speed, wind direction, and stability category for stations located at the 100, 200, 300, and 400 Areas.

3.5 NONROUTINE RELEASES OF RADIONUCLIDES TO THE ATMOSPHERE

No known instances of significant nonroutine emissions were reported in 2009. Any measurable contributions from unreported nonroutine emissions to the cumulative emissions from the Hanford Site would have been detected at ambient air monitoring stations located onsite or along the Hanford Site perimeter. The impacts of such emissions would be included in the dose estimates for fugitive sources, as described in Section 4.2.

3.6 ADDITIONAL COMPLIANCE INFORMATION

3.6.1 Applicability of Stack Emissions Data to Air Emission Permits and Licenses

The portions of the Hanford Site MEI dose attributable to individual point sources as listed in Section 2.0 are appropriate for use in demonstrating the compliance of abated stack emissions with applicable terms of the Hanford Site Air Operating Permit (AOP), FF-01, and any underlying NOC approvals.

3.6.2 Construction Projects and Modifications Exempted from 40 CFR 61.96

No exemptions of the approval process under 40 CFR 61.96 were granted in 2009. In 1992, the EPA determined that some emission units at the Hanford Site were out of compliance with requirements in 40 CFR 61, Subpart H. As a result, a National Emission Standards for Hazardous Air Pollutants (NESHAP) Federal Facility Compliance Agreement (FFCA) was made between DOE-RL and EPA Region 10. In 1994, EPA stated it would not grant any exemptions until all FFCA milestones were completed, which occurred by the end of 2005. Notwithstanding that achievement, extenuating circumstances involving the designation status of two stacks caused EPA to continue requiring its approval for all construction or modification projects, including those with a radiological dose potential of less than 0.1 mrem EDE per year.

3.6.3 Radon-220 and Radon-222 Emissions

Radon-220 and Rn-222 were emitted from the 325 Building via the EP-325-01-S major stack. The release values for these radon emissions are conservatively high engineering estimates, not derived from actual emission sample measurements. Radon-222 was also emitted from the 326 Building via the EP-326-01-S minor stack, and the release value is based on release records. The annual releases of these radon isotopes and respective doses are shown in Table 3-5. Radon is exempted from consideration in determining compliance with the dose standard of Subpart H of 40 CFR 61 yet is encompassed by state regulations, as in WAC-246-247-040(6), which states that “[a]ll emissions of radionuclides . . . are subject to the standards of this section” For 2009, the total dose from these two radon isotopes did not significantly increase the total dose from point and fugitive sources of radionuclide emissions from the Hanford Site.

Table 3-5. Emissions of ^{220}Rn and ^{222}Rn from the 325 Building and ^{222}Rn from the 326 Building, 300 Area, in 2009.

Stack (facility; contractor) ^b	Radionuclide	Emissions, Ci	EDE to MEI, ^a mrem
EP-325-01-S (325 Building; PNNL)	^{220}Rn	5.4 E+01 ^b	1.1 E-02
	^{222}Rn	7.0 E-01 ^b	3.8 E-03
EP-326-01-S (326 Building; PNNL)	^{222}Rn	5.0 E-09 ^c	2.6 E-11
Total			1.5 E-02

^a EDE = effective dose equivalent; MEI = maximally exposed individual, which in this case resides near Sagemoor Road, Franklin County, directly east of the 300 Area.

^b Release value conservatively calculated, not actually measured.

^c Value based on release records.

4.0 FUGITIVE SOURCES OF EMISSIONS

The Clean Air Act Amendments of 1990, promulgated in 54 Federal Register 16965, December 15, 1989, amended NESHAP regulations (i.e., 40 CFR 61, Subpart H) to govern emissions of radionuclides from DOE facilities and the resulting radiological doses to members of the public. A dose standard of 10 mrem/yr EDE was imposed, to which compliance is expected for radionuclide emissions emanating from point and fugitive sources. Measuring and/or modeling these emissions is fundamental to demonstrating compliance with the standard.

Beginning in 1991, the Hanford Site has annually apprised regulators of its methods for estimating fugitive emissions and modeling the resulting doses to a member of the public. An EPA-funded guidance document on methods to estimate fugitive emissions (EPA 2004, *Methods for Estimating Fugitive Air Emissions of Radionuclides from Diffuse Sources at DOE Facilities*) is available. The Hanford Site method is summarized in that document, along with methods used at other DOE sites. The guidance document does not pass judgment on the methods, instead leaving individual sites free to choose a method most suitable to their unique operations, locations, and configurations.

Note: For purposes of this report (i.e., DOE/RL-2010-17), the term *fugitive emission* refers to any potential source of radioactive material that is not actively monitored at the point of release. Such potential emission sources have been defined in various EPA and WDOH regulations as “fugitive,” “diffuse,” or “non-point” sources, arguably without definitions sufficient to guide a person to distinguish with certainty one type of emission from another. Thus, within this report, “fugitive emission” will also represent “diffuse emission” and “non-point emission.” EPA defines *fugitive emissions* as “those emissions which could not reasonably pass through a stack, vent, or other functionally equivalent opening” (40 CFR 70.2, *State Operating Permit Programs*). WDOH similarly defines fugitive emissions, but with a significant qualification, which has been underlined: “‘Fugitive emissions’ means radioactive air emissions which do not and could not reasonably pass through a stack, vent, or other functionally equivalent structure, and which are not feasible to directly measure and quantify” (WAC 246-247-030(12)). The WAC provides no definition of “non-point” sources; thus, such sources are assumed to be equivalent to diffuse sources as defined in DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*: “Diffuse Source is a source or sources of radioactive contaminants (emissions) released into the atmosphere that do not have a defined point (origin) of release (i.e., non-point source). Such sources are also known as area sources.” The dose-modeling method used at Hanford is not dependent on the regulatory distinctions among these types of sources for estimating fugitive emissions and their resulting contributions to the total dose from airborne radionuclides.

In general, fugitive sources of radioactive emissions are sources not actively ventilated, are not sealed to prevent the escape of volatile or resuspended radioactive material to the ambient air, and are not amenable to routine sampling in a controlled manner as stacks commonly are. Examples of sources of fugitive radioactive emissions are passively ventilated tank vents, vented containers, outdoor surface contamination areas, cracks between cover blocks, decommissioned buildings, etc. Emissions released from buildings to the ambient air via passive ventilation systems are also considered fugitive because they lack a measurable flow. Emissions from fugitive sources are monitored by the Hanford Site Surface Environmental Surveillance Program and the Near-Facility Monitoring Program, as described in Section 4.1. These emissions mix with ambient air, which may also have added to it emissions from point sources. Fugitive emission sources in and around Hanford Site facilities are described in Section 4.3.

That section also describes the monitoring program and use of monitoring data for characterizing fugitive emissions and the estimated maximum EDE to the public attributable to those emissions.

Measuring emissions from point sources (i.e., generally stacks) is ordinarily a prescriptive process, using well-defined technical methods, as described in 40 CFR 61 Subpart H, or alternatives approved by EPA, and includes applying atmospheric transport models to emissions measured at the facility stack. Subpart H monitoring methods, however, are not intended for nor amenable to measuring fugitive emissions. Moreover, assessing offsite doses from fugitive emissions is not nearly as straightforward as it typically is for point sources. It is complicated by such factors as (1) the difficulty in accurately quantifying air flow from the source, (2) the greater complexity in the influences from meteorological conditions, and (3) distinguishing radionuclides released from fugitive sources from preexisting low concentrations of radionuclides in ambient air, the origins of which could be background radioactive material and radionuclides from point sources.

To address the shortcomings inherent in monitoring fugitive emissions, EPA and DOE developed a mutual inter-agency Memorandum of Understanding (MOU) (Letter, DOE 1995, "Memorandum of Understanding Between the U.S. Environmental Protection Agency and the U.S. Department of Energy Concerning the Clean Air Act Emission Standards for Radionuclides 40 CFR Part 61 Including Subparts H, I, Q & T"). A principal agreement in this MOU was that the Subpart H dose standard applies not only to the radiological effects from point source emissions but from fugitive emissions as well. A further aspect of this agreement is that DOE facilities nationwide were to develop methods for evaluating fugitive emissions. Before the MOU was published, the Hanford Site had developed such a method, and thus has been in compliance with that condition in the MOU since its inception. The current *Department of Energy Hanford Site Air Emissions License #FF-011* (FF-01) discusses the acceptability of using Hanford Site ambient air monitoring data for demonstrating compliance with radiological dose limits. Also, the FF-01 prescriptively describes in fair detail the Hanford Site method of estimating fugitive emissions and the corresponding radiological dose to the MEI. In Section 5.0, Method for Monitoring and Reporting of Diffuse and Fugitive Emissions, of the FF-01 is the direction that the "average aggregate emissions from diffuse sources will then be used to estimate the dose at the Hanford Site perimeter with the CAP88-PC code." Compliance to this direction was achieved for 2009, as well as in earlier years.

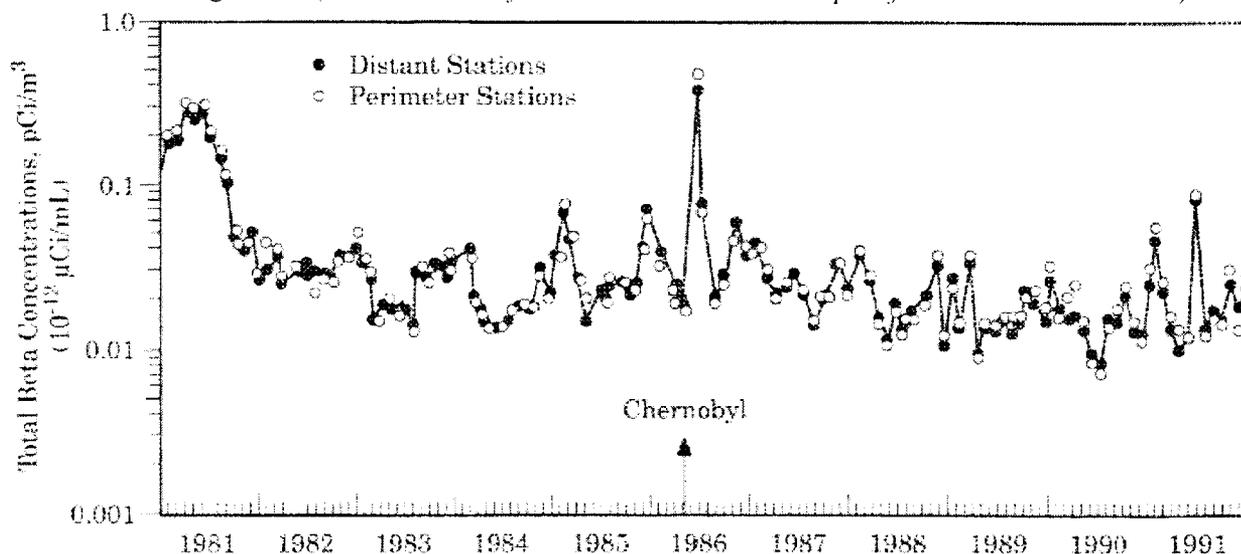
With respect to dose effects from fugitive emissions, WDOH regulations are consistent with the MOU, as evidenced by WAC 246-247-010(2), which states that the Subpart H dose standard applies to "point sources, nonpoint sources, and fugitive emissions." However, WAC 246-247-030(12) acknowledges that fugitive emissions "are not feasible to directly measure and quantify." This admission underscores the technical difficulties and inherent complexities in estimating fugitive emissions and their dose effects. Despite such challenges, the Hanford Site method affords a defensible and conservative estimate of fugitive radionuclide emissions and resulting doses, which are reported annually, both individually and in combination with the maximum dose from point source emissions, radon doses, and, as warranted, the doses from nonroutine airborne releases. Summing the doses from all of these radiological sources of emissions assures a comprehensive compliance determination against the Subpart H dose standard.

Currently, all nuclear material production facilities at the Hanford Site have been shut down, are undergoing cleanup and demolition, or placed in surveillance-and-maintenance mode. Only waste minimization, stabilization processes, research activities, environmental remediation, and decontamination and decommissioning (D&D) continue. In the past, when the Hanford Site was operating at or near full capacity, point source emissions were easily detected. Now, however, radioactive materials released from point sources have in large part diminished to background levels found in the ambient environment. Therefore, the contribution from fugitive emissions has become a larger percentage of total emissions from the Hanford Site, even though fugitive emissions have thus far remained relatively small and constant.

Passively ventilated point sources, breather vents and other openings on tanks, vaults, vented containers, and other structures are potential conduits of radioactive emissions. Airborne radionuclides inside vented structures can be released through passive air exchanges, typically caused by changes in atmospheric pressure and temperature. It is difficult, however, to accurately assess radionuclide releases that might occur under such conditions, particularly when a vent opening is irregularly shaped or when multiple openings are in close proximity. This difficulty in accurately and readily quantifying passively ventilated emissions is the main reason why these sources are not routinely sampled using conventional sampling methods. However, low emissions can be verified using other approved means such as smears, non-destructive analysis, occupational continuous air monitors, and direct radiation measurement using hand-held instruments. As an alternative to routine record sampling, estimates of radionuclides discharged as fugitive emissions from such sources are made based on data collected from a network of ambient air samplers around the downwind perimeter of the Hanford Site. Fugitive radionuclide releases estimates are then calculated using these data. Section 4.2 contains the dose and release estimates and resulting doses for Hanford Site fugitive emissions in 2009.

For this report, doses have been calculated for emissions from both actively ventilated point sources and fugitive sources. Dose results for each type of release are presented separately, in addition to the totals for all sources of radioactive emissions. The older historical data displayed in Figure 4-1 sharply illustrates the impacts distant nuclear events in the world had on regional concentrations of airborne radioactivity, measured by the Hanford Site Surface Environmental Surveillance Project. It is noteworthy that ambient air concentrations from sample locations at the Hanford Site perimeter are seen to differ little from concentrations measured at locations distant from the Hanford Site.

Figure 4-1. Historical Impact of Gross Beta Radioactivity in Hanford Site Ambient Air Samples, 1981 through 1991 (PNL-8148, *Hanford Site Environmental Report for Calendar Year 1991*).



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4.1 FUGITIVE EMISSIONS MONITORING

At the Hanford Site, two programs, the Near-Facility Environmental Monitoring Program and the Surface Environmental Surveillance Project, monitor radionuclides in the environment at locations on and off the Hanford Site. Further program and project information is presented in the remainder of this section.

4.1.1 Near-Facility Environmental Monitoring

Near-facility environmental monitoring is defined as monitoring done near facilities that have potentially dispersible radioactivity. Monitoring locations are associated mostly with major nuclear facilities and waste storage or disposal facilities such as container storage, burial grounds, underground tanks (i.e., Tank Farms), ponds, cribs, trenches, and ditches.

Routine monitoring activities include the sampling and monitoring of ambient air, surface contamination, external radiation doses, soil, vegetation, and animals. Samples are collected from known or expected effluent transport pathways, which are generally downwind of potential or actual airborne releases and downgradient of liquid discharges. Ambient air sampling is the primary method used in monitoring fugitive emissions, with other media samples possibly useful as secondary indicators.

In 2009, airborne radioactivity was sampled by a network of 84 ambient air samplers operated as continuously as possible at locations near facilities, as shown in the following list:

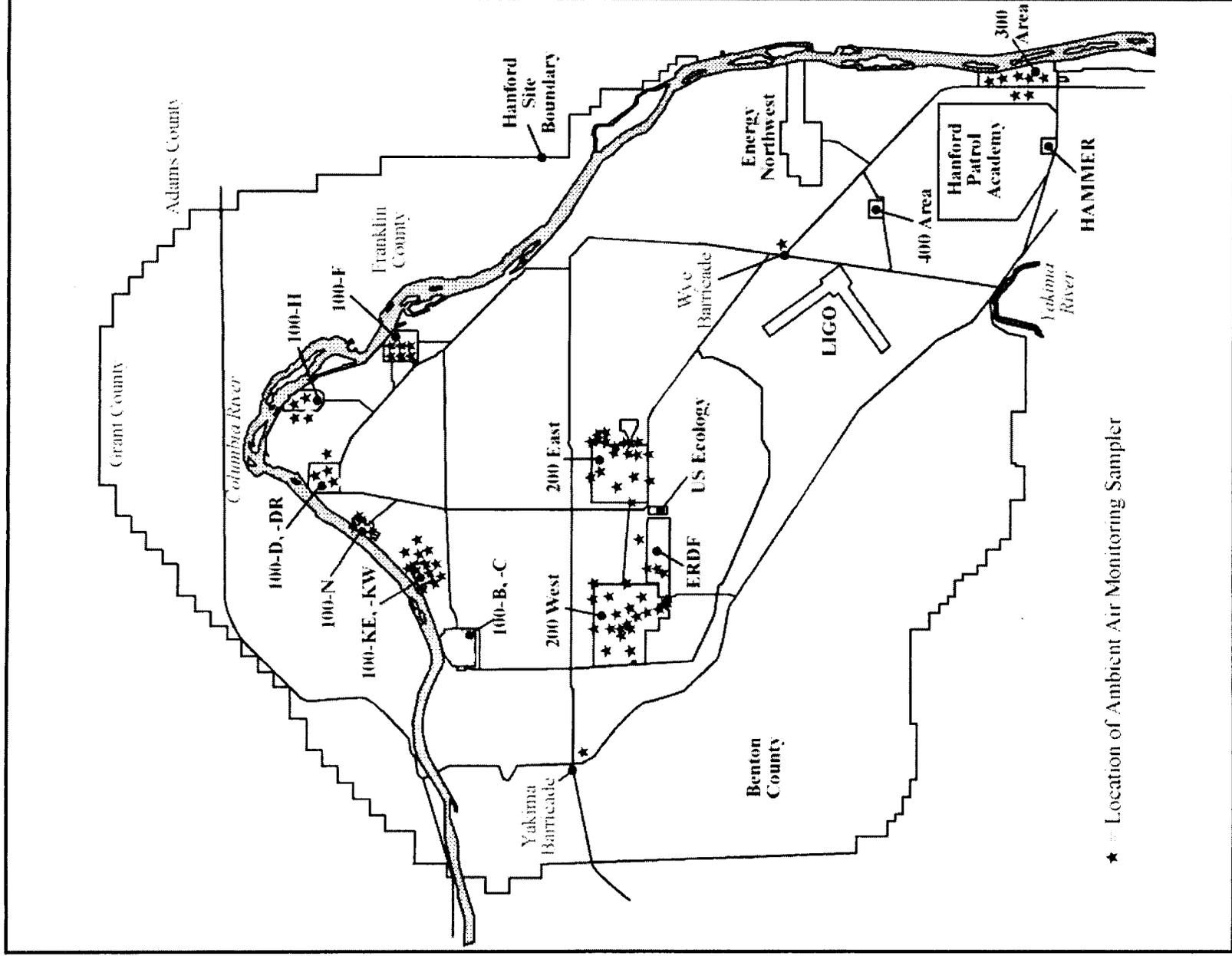
<u>Number of Samplers</u>	<u>Location</u>
4	100-D Area
4	100-H Area
10	100-K Area
3	100-N Area
45	200 Areas
3	ERDF
7	300 Area
8	600 Area
1	Yakima Barricade (PNNL)

Figure 4-2 identifies the general locations of the ambient air samplers used for near-facility monitoring. The station at the Wye Barricade is collocated with samplers operated by the PNNL Surface Environmental Surveillance Project and WDOH. Four other stations have WDOH samplers collocated with them: one each at 100-KE, at ERDF, at the 216-ZPIC Trench, in the 200 West Area, and at C Tank Farms in the 200 East Area. Additional samplers are also used to support specific environmental remediation tasks. Ambient air samplers are primarily located at or near (within about 1,600 ft [500 m]) sites and facilities having the potential for or history of environmental releases. Particulate air samples are analyzed for gross alpha activity, gross beta activity, gamma-emitting isotopes, ^{90}Sr , uranium isotopes (^{234}U , ^{235}U , and ^{238}U), and plutonium isotopes (^{238}Pu and $^{239,240}\text{Pu}$). Gamma-emitting isotopes reported over the years include ^{60}Co , ^{106}Ru , ^{125}Sb , ^{134}Cs , ^{137}Cs , ^{154}Eu , and ^{155}Eu . Samples collected at selected locations are also analyzed for ^{241}Am and/or ^{241}Pu . More detailed descriptions of these monitoring activities can be found in PNNL-19455 and PNNL-19455, APP. 2, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 2009*.

4.1.2 Surface Environmental Surveillance

Surface environmental surveillance encompasses sampling and analyzing for radiological contaminants at locations in four surveillance zones on and off the Hanford Site. The first surveillance zone extends from the near-facility monitoring locations to the Hanford Site perimeter. The second zone consists of a series of perimeter sampling stations near or just inside the Hanford Site boundary and along State Highway 240. The third zone consists of nearby community sampling locations within a 30-mi (48-km) radius of the Hanford Site. The fourth zone (i.e., background locations) currently consists of a single distant community location upwind of the Hanford Site and considered unaffected by its operations.

Figure 4-2. Near-Facility Ambient Air Sampling General Locations.



Routine surveillance activities include the sampling and monitoring of air, surface water, groundwater, food and farm products, fish and wildlife, soil and vegetation, and external radiation. Like the near-facility monitoring program, ambient air sampling is the primary method used in monitoring fugitive emissions.

The air surveillance network consists of 40 sampling stations, of which 21 are onsite, 11 at the Hanford Site perimeter, 7 in nearby communities, and 1 in a distant community considered a background location. This program routinely monitors for radioactive vapors, gases, and aerosols, which at selected locations includes sampling for ^3H in the ambient air. The surveillance network located around the 300 and 400 Areas functions as a near-facility network.

Airborne particulate radionuclides at all sampling stations are sampled and analyzed. Particulate air samples are routinely analyzed for gross alpha activity, gross beta activity, gamma-emitting isotopes, ^{90}Sr , uranium isotopes (^{234}U , ^{235}U , and ^{238}U), and plutonium isotopes (^{238}Pu and $^{239,240}\text{Pu}$). Gamma-emitting isotope concentrations reported in 2009 include ^{60}Co , ^{106}Ru , ^{125}Sb , ^{134}Cs , ^{137}Cs , ^{152}Eu , ^{154}Eu , ^{155}Eu , and ^{241}Am . Figure 4-3 depicts the locations of the ambient air samplers in the Surface Environmental Surveillance Project. A more detailed description of this program can be found in PNNL-16984.

4.2 ESTIMATED DOSES FROM FUGITIVE EMISSIONS

Potential releases from fugitive sources and the resulting dose to an offsite member of the public were estimated using ambient air monitoring data from environmental surveillance air sampling locations along the Hanford Site perimeter. Data from 15 selected perimeter and nearby community locations were used in the assessment of fugitive emissions in 2009 (refer to Figure 4-3, sampling locations 24–38).

4.2.1 Dose Assessment Method

The method currently used to estimate emissions from fugitive sources at the Hanford Site, and the subsequent dose to a maximally exposed member of the public, is based on measured ambient air concentrations at the site perimeter. Contributions from monitored stack emissions and background radioactivity are subtracted from ambient air concentrations measured for each radionuclide. If the difference is positive, the result is attributed to fugitive sources. From the adjusted ambient air concentrations, CAP88-PC is used to back-calculate fugitive releases in curies per year, conservatively assumed to emanate from a single, centralized location in the 200 West Area, an assumption that yields the largest release estimate. This is an indirect method for estimating fugitive emissions, but is subject to less uncertainty in estimating dose to a member of the public because it uses actual monitoring data from the site perimeter where members of the public could be located. This method is also far more cost effective than estimating fugitive emissions from the resuspension of particulate radionuclides from over 1,000 potential fugitive emission sources at the Hanford Site. A document was recently published that not only details the method and procedures used to estimate Hanford Site radiological doses to the MEI from both radioactive point source and fugitive source emissions but also offers a brief history of relevant federal and state regulations and agency agreements (refer to DOE/RL-2007-53, *Methods for Calculating Doses to Demonstrate Compliance with Air Pathway Radiation Dose Standards at the Hanford Site*). This document evolved out of several DOE discussions with EPA and WDOH on the topic of the Hanford Site MEI. WDOH personnel participated in the review phase of the document and accepted the manner in which their resulting comments had been incorporated into it.

Current information on the extent and characteristics of onsite soil contamination is insufficient to use radionuclide resuspension estimates in conjunction with transport and dose modeling for many potential sources of fugitive emissions. The ambient air sampling results consisted of measured air concentrations for radionuclides that could be released from Hanford Site operations and fugitive sources. Radionuclides routinely assayed in ambient air samples include ^3H , ^{60}Co , ^{90}Sr , ^{137}Cs , ^{234}U , ^{235}U , ^{238}U , ^{238}Pu , and $^{239,240}\text{Pu}$ (PNNL-16984).

Using the CAP88-PC atmospheric dispersion modeling code, radionuclide air concentrations resulting from monitored stack emissions at Hanford Site facilities and other nearby non-DOE sources were calculated for perimeter and nearby community sampling locations. These modeled airborne radionuclide concentrations attributable to the stack emissions were subtracted from the ambient monitoring results. Average regional background concentrations for each radionuclide were calculated from the air sample results obtained at the distant community sampling station in Yakima, outside the 80-km (50-mile) radius and historically upwind from Hanford Site sources. The average background concentration at that station was also subtracted from the ambient monitoring results at the Hanford Site perimeter stations. The net air concentrations at the site perimeter, adjusted to account for monitored emission sources and background concentrations, are assumed to be the contribution of emissions from fugitive sources.

Hypothetical releases of radionuclides from fugitive sources are estimated using the net perimeter air concentrations attributable to fugitive emissions and by performing a back-calculation using CAP88-PC. The 200 West Area near the center of the Hanford Site is assumed to be the source of all fugitive emissions. This assumption results in a conservatively high estimate of releases and doses from all fugitive sources. The average of the estimated emissions for each perimeter monitoring station is then used with CAP88-PC to estimate the dose at the Hanford Site perimeter. Table 4-1 displays results from the perimeter monitoring location having the highest estimated dose from fugitive emissions, as well as the dose at the location of the member of the public who received the highest dose from monitored point source emissions. A combined dose to a member of the public comprising the highest dose from monitored point source emissions and the dose at that location from estimated fugitive source emissions is reported and evaluated for compliance with the 10 mrem/year standard in 40 CFR Part 61, Subpart H.

4.2.2 Results of Dose Assessment

During 2009, the measured annual average ambient air concentrations of ^3H , ^{60}Co , ^{137}Cs , ^{238}Pu , ^{239}Pu , and uranium (modeled as ^{234}U) at the perimeter and nearby community sampling locations were assessed to be greater than the combined contributions of these analytes from stack releases and background. Thus, calculating the net fugitive air concentrations for these isotopes resulted in positive values. Calculating the net fugitive air concentrations for ^{90}Sr resulted in negative values. All of the net air concentrations, both positive and negative, for each radionuclide were used in back-calculating fugitive releases from the 200 West Area.

The fugitive source releases shown in Table 4-1 represent the average of the individual release estimates calculated from each of the perimeter and nearby community locations for each radionuclide. Note that not all radionuclides were evaluated at every sampling station; the estimated release of a radionuclide is based on analytical data associated with those stations from which samples were analyzed for that particular radionuclide.

When the resulting release estimate in Table 4-1 is less than zero for an individual radionuclide, the average of the air concentrations at the perimeter stations was smaller than the combined concentrations expected as a result of stack emissions and regional background. In such cases, it is unlikely that fugitive sources contributed significantly to the offsite measured air concentrations for those radionuclides.

Table 4-1. Estimated Hanford Site Fugitive Emissions and Resulting Effective Dose Equivalents for 2009^a

Radionuclide ^b	Estimated fugitive emissions from 200 Areas (Ci) ^c	Location	
		Estimated dose to MEI at Sagemoor (mrem) ^d	Estimated dose at Prosser Barricade (mrem) ^e
³ H	8.1 E+02	1.1 E-02	1.6 E-02
⁶⁰ Co	1.1 E-01	1.2 E-03	2.1 E-03
⁹⁰ Sr	-1.6 E-01	0	0
¹³⁷ Cs/ ^{137m} Ba	3.4 E-02	1.1 E-03	1.9 E-03
Total U	4.1 E-02	3.6 E-03	6.1 E-03
²³⁸ Pu	3.4 E-05	3.8 E-05	6.4 E-05
²³⁹ Pu	3.7 E-03	4.5 E-03	7.6 E-03
Total ►		2.1 E-02	3.4 E-02

^a Hanford Site stack emissions, background radioactivity, and emissions from Perma-Fix Northwest, Inc., AREVA Federal Services LLC, and the ENCGS have been subtracted from these fugitive emissions estimates, which may contain releases from other non-DOE nuclear facilities. Negative values for releases of a radionuclide indicate that air concentrations at the site perimeter are lower than the combined air concentrations expected from natural background and monitored stack releases.

^b Not all radionuclides listed were evaluated at every sampling station.

^c 1 Ci = 3.7 E+10 Bq. Emissions from fugitive sources are assumed to originate in the Hanford Site 200 Areas and have a release height of 1 m. The 300 Area also has potential sources for the resuspension of uranium from soil, along with naturally occurring uranium isotopes found throughout the area. Uranium releases were modeled as if the total inventory were from the 200 Areas, because it was not possible to determine the source of uranium isotopes detected at offsite sample stations.

^d 1 mrem = 1.0 E-02 mSv; these doses are based on air monitoring results for sample stations at the site perimeter. Radionuclides with negative releases are assumed to have a zero dose.

^e The highest estimated dose from fugitive emissions was at the Prosser Barricade, a location with no full-time occupancy by a member of the public, which disqualifies it for consideration as a possible MEI location.

The estimated fugitive releases for the sampled radionuclides were also used to calculate the dose at perimeter sampling stations. An individual at the Prosser Barricade sampling station, which is within the Hanford Site boundary, had the highest estimated dose, whereas the Byers Landing station was closest in distance to Sagemoor Road, the location of the MEI having the highest dose from point source emissions. Table 4-1 shows the hypothetical mean dose from fugitive emissions to an individual at Sagemoor Road and to an individual at the Prosser Barricade to be 0.021 mrem (0.00021 mSv) EDE and 0.034 mrem (0.00034 mSv) EDE, respectively. The doses at the other sampling stations and potential MEI locations were lower than those at the Prosser Barricade location. For purposes of demonstrating compliance with the MEI dose standard, the Sagemoor dose was chosen instead of the Prosser Barricade dose for adding to the point source dose at Sagemoor Road. The reason is three-fold. One, regardless of the size difference between doses from point source emissions and from fugitive source emissions, the method used to calculate the dose from point source emissions is given primacy because it is agency-approved and based much more on real measurements, whereas the method used to calculate the fugitive emission dose is substantially hypothetical, quite conservative, and not yet officially approved by EPA or WDOH, although both agencies have been cognizant of it for years. Two, the fugitive-dose method centers on a single point of origin for all fugitive emissions, which adds to the conservative quality of the method,

whereas the point-source method is presumed to be more reflective of actual emissions because it uses mostly measured emission values from five different geographical operating zones across the Hanford Site. And three, the location of the highest fugitive-source dose is within the Hanford Site boundary, where a member of the public would not be allowed full-time unrestricted access, and will invariably under the current fugitive dose method be attributed a higher dose than other potential MEI locations that are not in the direct downwind path of the hypothetical point of emanation in the 200 West Area for all Hanford Site fugitive emissions.

Where the release estimate for a particular radionuclide was less than zero, the dose estimate for that nuclide was set equal to zero before combining the contributions of all radionuclides to obtain the total dose at each location. The MEI dose derived from 0.032 mrem (0.00032 mSv) EDE from point source emissions, 0.021 mrem (0.00021 mSv) EDE from fugitive emissions, and 0.015 mrem (0.00015 mSv) EDE from radon emissions originating from two point sources. For 2009, the total estimated dose to the offsite Sagemoor Road MEI was 0.068 mrem (0.00068 mSv) EDE, which is significantly below the federal and state 10 mrem/yr standard. For purposes of comparison to the 2009 Sagemoor Road MEI dose, the MEI location in 2008 was also at Sagemoor, where the total estimated dose was 0.11 mrem (0.0011 mSv) EDE, comprising 0.041 mrem (0.00041 mSv) EDE from point source emissions, 0.052 mrem (0.00052 mSv) EDE from fugitive emissions, and 0.021 mrem (0.00021 mSv) EDE from radon emissions.

In addition to the site-wide fugitive emissions estimates, fugitive tritium emissions from two sources during 2009 were estimated to determine their contribution to the public radiological dose. Tritium emissions from the 100-K Spent Fuel Storage Basins were estimated as less than 2 Ci/yr ($7 \text{ E}+10$ Bq/yr), and those from the 200 Area Tank Farms were estimated as less than 6 Ci/yr ($2 \text{ E}+11$ Bq/yr). Emissions from both sources were assumed to be in the form of tritiated water vapor. These emission rates have been applied historically and do not reflect any source reductions that have occurred over the last decade, such as the end of operations at the 100-KE fuel storage basin in 2008. Therefore, these emission rates and resulting doses are overestimates. For 2009, the resulting dose to the Hanford Site MEI from estimated fugitive tritium emissions from both the 100-KE and 100-KW basins was $1.2 \text{ E}-5$ mrem ($1.2 \text{ E}-7$ mSv) EDE and $6.6 \text{ E}-5$ mrem ($6.6 \text{ E}-7$ mSv) EDE for tritium emissions from the 200 Area Tank Farms.

Additional fugitive emissions were identified at the 361 Building from radio-xenon calibration sources. Emissions during 2009 were estimated at $2 \text{ E}-9$ Ci (74 Bq) of Xe-131m, $1 \text{ E}-7$ Ci (3,700 Bq) of Xe-133, and $1 \text{ E}-9$ Ci (37 Bq) of Xe-135. The dose in 2009 to the Hanford Site MEI from those emissions was $6.6 \text{ E}-13$ mrem ($6.6 \text{ E}-15$ mSv).

4.2.3 Estimate of Uncertainty in Dose Assessment

To estimate uncertainty in the dose estimates, the reported air concentrations for 2009 at the Byers Landing sampling station and at the distant community station in Yakima were used to estimate the mean and 95-percent confidence intervals for each location. The analysis used the uncorrected air concentrations at the reference locations, including contributions from monitored point source releases at DOE facilities, sources other than DOE facilities, fugitive sources, and regional background. The Byers Landing station was selected for this analysis because it was closest to the Hanford Site MEI and is a perimeter station at which all radionuclides were evaluated. The distant offsite and upwind Yakima location is assumed to represent regional background levels of radionuclides in the ambient air.

The uncertainty calculation was performed using the GENII-S computer code (SAND91-0561A, *User's Guide for GENII-S: A Code for Statistical and Deterministic Simulations of Radiation Doses to Humans from Radionuclides in the Environment*) to produce a stochastic analysis of the environmental radiation

doses. The raw values of the measured air concentrations were input as basic concentrations to define an empirical distribution for each radionuclide. The code used a Latin hypercube sampling routine to select random values for each radionuclide concentration in 300 trials to obtain the dose distribution for each location. The values of parameters other than the radionuclide air concentrations were those recommended for use at the Hanford Site (DOE/RL-2007-53) and were not varied as part of this analysis. Therefore, the uncertainties reported in this section reflect only variability in the air sampling data. It should be noted that dose estimates using GENII-S are based on the dosimetry system described in Federal Guidance Reports 11 and 12 (EPA 1988, 1993), whereas compliance calculations using CAP88-PC are based on the more recent dosimetry system described in Federal Guidance Report 13 (EPA 1999).

The estimated mean dose at the Byers Landing station was 0.17 mrem (0.0017 mSv) for artificially produced radionuclides sampled at that location, with a 95-percent confidence interval of 0.12 to 0.25 mrem (0.0012 to 0.0025 mSv). The result for the distant community monitoring station was 0.12 mrem (0.0012 mSv) with 95-percent confidence limits of 0.078 to 0.29 mrem (0.00078 to 0.0029 mSv). Although its mean is slightly greater than the distant community result, the Byers Landing dose falls within the 95-percent confidence interval of the distant community dose estimate.

4.2.4 Discussion of Bias in Dose Assessment

It should be noted that the release estimates for fugitive sources in Table 4-1 were obtained using CAP88-PC, which incorporates a continuous-release Gaussian-plume dispersion model. Releases from fugitive sources would be expected to occur primarily under conditions that are very different from the annual average assumptions used by CAP88-PC. This is particularly true for emissions that are a function of wind speed, such as resuspension of contaminated soil and evaporation from ponds. Because release rates from such sources are greatest under conditions that favor atmospheric dispersion, use of an annual average continuous release model to back-calculate the release quantities might introduce a significant bias into these estimates. The dose estimates for sources of this type might also be affected by seasonal variation in the resuspension rates caused by the prevalence of strong winds during certain seasons of the year. If those seasonal episodes occur primarily during times when crop production is minimal, some of the exposure pathways incorporated into the CAP88-PC code (direct deposition on human and animal food crops, for example) would not be applicable. The release and dose estimates reported for fugitive sources in this evaluation should therefore be viewed as approximations whose accuracy is limited by a number of factors inherent in the sampling and modeling process.

4.3 FUGITIVE EMISSION SOURCES

The Hanford Site consists of 586 mi² (1,518 km²) of semiarid shrub-steppe land, of which approximately 6 percent (about 32 mi² [83 km²], or 20,000 acres [8,090 ha]) has been disturbed and/or actively used. This 6 percent of land is distributed into large operational and support areas: the 100, 200 Areas (which includes the 200 East and 200 West Areas), 300, 400, and 600 Areas.

Almost all point and fugitive sources of radionuclide emissions are located in the five operational Areas (i.e., 100, 200 East, 200 West, 300, and 400 Areas). For dose modeling purposes, sources outside those operational areas are combined with sources within the nearest operational area. Most point source emissions are measured directly, but at a few facilities they are conservatively calculated from process knowledge. Emissions from fugitive sources are estimated using sample results from a network of environmental surveillance monitoring systems located along the Hanford Site perimeter and at several receptor locations. In some instances, emissions from specific fugitive emission sources are based on known inventories and/or release records.

The Hanford Site was acquired in 1943 and dedicated to producing plutonium for national defense and managing the resulting production wastes. Restoring the Hanford Site environment is the new mission that has largely supplanted the previous operational objectives for national defense. The environmental restoration effort will entail activities such as decontaminating and decommissioning over 100 facilities and cleaning up and restoring about 1,500 waste sites. Until the restoration and cleanup work is completed, radioactive emissions may be released from hundreds of fugitive sources, in addition to monitored point sources.

Besides both measuring and modeling point source emissions to determine public doses, environmental surveillance is conducted. Environmental and food-chain pathways are monitored near facilities emitting radionuclides from either point sources or fugitive sources.

The environmental pathways for all air emissions from the Hanford Site are monitored using a stratified sampling approach. Samples are collected and radiation measured according to four surveillance zones. These zones extend from main onsite operational areas to offsite regions (PNNL-19455).

The first surveillance zone begins near the operating facilities and ends at the Hanford Site perimeter. Fugitive emissions generally will be most concentrated and easier to detect in this area before diluting further as they drift offsite.

The second surveillance zone is a series of sampling stations that surround the Hanford Site near its perimeter. Because a person could live as close to the Hanford Site as some of these stations, their data represent the maximum exposures for a member of the public. Therefore, ambient air sampling data from the perimeter locations most closely reflect the actual impacts of radionuclide air emissions from point sources and fugitive sources at the Hanford Site.

The third surveillance zone encompasses nearby and distant communities within a 50-mi (80-km) radius of the center of the Hanford Site but beyond its boundaries. Surveillance is conducted in communities to provide measurements at those locations where the most people are potentially exposed. This surveillance ensures radionuclide levels are well below standards established to protect the public health.

Finally, the fourth surveillance zone comprises distant locations at which background concentrations are measured. These concentrations are compared with onsite, perimeter, and community locations to indicate the effects of Hanford Site activities. Background locations are essentially unaffected by Hanford Site emissions but contain similar levels of radioactivity originating naturally and from nuclear-testing fallout.

The goal of environmental surveillance at the Hanford Site is to verify compliance with DOE, EPA, and WDOH radiological dose standards for public protection. This goal is accomplished by measuring radionuclides and consequent exposure in the onsite and offsite environment. The environmental surveillance criteria are derived from (1) the collected environmental surveillance data on radionuclides and doses, (2) applicable regulations other than DOE Orders, 3) DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, and 4) DOE/EH-0173T. The surveillance project (refer to PNNL-19455, APP. 1, *Hanford Site Environmental Surveillance Data Report for Calendar Year 2009*) was established on these criteria and the pathway analyses that provide information on radionuclides and media contributing to human dose. Experience from Hanford Site environmental surveillance activities and studies conducted over the past 45 years has built an invaluable technical repository of information for planning and data interpretation.

4.3.1 Description of Fugitive Emission Sources

The presently identified actual or potential sources of fugitive radionuclide emissions to the environment at the Hanford Site are described in this section. Among the sources that could release radioactive fugitive emissions are several types of waste handling and disposal facilities such as cribs, ponds, ditches, trenches, retention basins, valve pits, French drains, reverse wells, tanks, vented containers, and burial grounds. Over 1,000 of these types of sources have been identified, of which more than 95 percent are inactive (DOE/RL-88-30, *Hanford Site Waste Management Units Report*). Facilities that are operating, on standby, or inactive can also be sources of radioactive fugitive emissions. These following activities can also cause the release of radioactive fugitive emissions: deactivation, decontamination, decommissioning, and demolition of facilities; characterization of waste sites and areas; and cleanup of inactive waste sites. Each waste site or facility usually has one or more features or characteristics that could contribute to the release of fugitive emissions. The features may be passive vents, risers, equipment and personnel access doors, and exhausters, whereas characteristics may include an undetected leak, unburied waste, or an absence of intrusion barriers. Rates of fugitive emissions could be influenced by a variety of environmental conditions, such as: (1) changing atmospheric pressures, (2) wind speed, (3) erosion, (4) evaporation, (5) percolation, and (6) biotic intrusion. Range fires present another cause of fugitive emissions, by way of smoke from burned material that contained radioactive particles and the resultant loss of vegetative cover, which had served to retard the resuspension of surface soil contaminants.

The general types of sites and facilities and their potential primary sources of fugitive emissions are briefly described in the following sections.

4.3.1.1 Crib

Low-level liquid waste was discharged to cribs, which are subsurface systems similar to sanitary drain fields that allow the liquid component of the waste to percolate into the soil. The natural properties of the soil are used to remove radioactive material from the effluent water through filtration, ion-exchange, and precipitation reactions.

Many cribs are vented to the atmosphere through vents and pipe risers. Some cribs, however, have had vents and pipe risers either blanked or removed. Those engineered structures promote the downward flow of liquids disposed of in cribs but also provide pathways to the surface and atmosphere. Secondary causes of fugitive emissions include erosion and uptake and intrusion by biota, followed by wind-caused particle resuspension.

4.3.1.2 Ditch

A ditch is an open, unlined excavation used for disposing of liquid effluents or transporting liquid effluents to ponds for disposal. Most ditches, however, have been filled with soil. Fugitive emissions from ditches occur primarily from wind-caused particle resuspension, vegetative uptake, biota intrusion, and erosion.

4.3.1.3 Trench

Early disposal practices included disposing of liquid effluents into unlined trenches and over time filling the structures with soil. These trenches were mostly replaced by cribs such as the BC-cribs. Fugitive emissions from trenches are primarily caused by erosion, uptake and intrusion by biota, followed by wind-caused particle resuspension.

4.3.1.4 Retention Basin

Similar to trenches, retention basins generally were lined with concrete and used to hold liquid before routing it to ditches or ponds. Fugitive emissions from retention basins are caused primarily by wind-caused particle resuspension.

4.3.1.5 Diversion Box

A diversion box is usually an underground concrete structure formed around a junction of transfer lines carrying liquid effluent. When diversion boxes are accessed for operations or maintenance, radioactively contaminated material might be released in the form of fugitive emissions.

4.3.1.6 Valve Pit

A valve pit is similar in structure to a diversion box, but contains piping valves. When valve pits are accessed for maintenance or operations, radioactively contaminated material might be released in the form of fugitive emissions.

4.3.1.7 French Drain and Reverse Well

A French drain is a rock-filled encasement inserted in the ground. A reverse well is an ordinary well used for mixing liquid waste with groundwater. These subsurface systems were used to dispose of potentially contaminated liquid waste by promoting percolation into the soil. The natural filtration properties of the soil removed radioactive material from effluent water. Fugitive emissions from French drains and reverse wells might occur through erosion or uptake and intrusion by biota, followed by wind-caused particle resuspension.

4.3.1.8 Tank

A tank generally is a large reinforced metal structure that receives liquid effluent for storage. Examples are DSTs and SSTs. Pathways for fugitive emissions from tanks include passively ventilated point sources and inactive exhausters open to the atmosphere. Transport mechanisms for these emissions include deposition and subsequent particle resuspension.

4.3.1.9 Burial Ground

Burial grounds are trenches in which contaminated solid waste is buried. Waste packaging procedures and burial practices used depend on the type of waste. Fugitive emissions occur at burial grounds through direct release to the atmosphere before the waste is buried, but could occur after burial by way of erosion, vegetative uptake, biota intrusion, and wind-caused particle resuspension.

4.3.1.10 Deactivation, Decontamination, Decommissioning, and Demolition Activities

Deactivation, decontamination, decommissioning, and demolition activities are conducted to minimize the potential release or spread of contamination from facilities and equipment. Deactivation activities are intended to remove facility systems and/or areas from operational service to make them ready for the facility transition phase in which facilities are either converted to another use or placed in a permanent shutdown condition. Activities could include removal of fuel; draining and/or de-energizing of systems; removal of accessible stored radioactive and hazardous material; and other actions that place the facility systems and/or areas in a safe and stable condition. Deactivation reduces the risk to the public and the

environment until the ultimate disposition of each facility is decided and implemented, and allows the surveillance-and-maintenance program to be conducted more cost effectively.

Decontamination primarily consists of physically removing contaminants, but can also include fixing contaminants in place, to the extent they are not smearable, to prevent their mobility during demolition. Methods might include washing with water, scraping, sandblasting, or fixing the contamination in place by painting, applying asphalt, etc. Demolition involves destroying and removing the structure and might include excavating its foundation. In some cases, contaminated material might be exposed to the atmosphere, but proper planning and controls should minimize these exposures. Monitors around demolition sites are used to measure or indicate the effectiveness of controls.

4.3.1.11 Waste Site Characterization and Cleanup Activities

Characterization is performed to determine the extent of contamination. Cleanup activities are conducted to minimize the potential release or spread of contamination from inactive waste sites. Contaminated soils and structures are excavated and transported to ERDF for disposal. Contaminated materials are exposed to the atmosphere during excavation and disposal activities. Proper planning and controls such as water sprays and fixatives are used to minimize the potential for airborne emissions. The waste sites are backfilled after excavation and the disposed material is covered with soil.

4.3.1.12 Outdoor Radioactive Surface Contamination Areas

All of the following outdoor radioactive surface contamination areas are routinely surveyed: burial grounds, cribs, trenches, retention basins, and identified unplanned release sites. The surveys are performed at least annually, but more frequently when needed. The areal magnitude of outdoor surface contamination varies. The magnitude is not fixed because of continuing efforts to clean, stabilize, or remediate known contaminated areas while new areas of contamination are continuing to be identified. Newly identified contamination could result because of preexisting contamination having migrated, by way of wind or biological intrusion, to previously uncontaminated areas or because the radiological screening criteria have become more stringent.

Contaminated areas are posted as Radiologically Controlled Area, Soil Contamination Area, or Underground Radioactive Material Area. Radiologically controlled areas are areas having a potential for an individual to receive an annual dose of up to 100 mrem. Soil contamination areas have more widespread contamination, and can have a potential for an individual to receive an annual dose of more than 100 mrem. Underground Radioactive Material Area signs mark cribs, burial grounds, covered trenches, and ponds, but not underground plumes that extend away from these sites. If an area has soil contamination and underground contamination, such as a surface contaminated crib, both postings will be used. The general location, by area, and the approximate area of soil contamination and underground contamination are shown in Table 4-2. Fugitive emissions from areas of soil contamination are primarily caused by erosion, plant uptake, biota intrusion, and wind-caused particle resuspension.

4.3.1.13 Structures with Radioactive Contamination

Structures having indoor contamination and not actively ventilated through a point source could be sources for fugitive emissions. Many structures control fugitive emissions with ventilation systems and contamination control practices. Ventilation systems generally help maintain a negative indoor air pressure and can significantly reduce airborne contaminants from leaving the building by use of pollution abatement systems. Many structures with ventilation systems discharge air to the atmosphere via an emission control device, typically a HEPA filter. Facilities having a potential to emit radioactive contaminants and have actively ventilated and filtered point sources that are routinely sampled are not

considered a source of fugitive emissions. This type of facility has the potential, though lesser in extent, than facilities not equipped with active ventilation systems but with a comparable source term. The Hanford Site has many old structures with radioactive contamination and no building ventilation. Contaminants can sometimes migrate outdoors via human entry and exit. Also, contaminants can migrate outdoors via passive ventilation or animal intrusion because these structures often have cracks and gaps that serve as pathways to the outdoors. Once the contaminants are transported outdoors, they can become airborne by wind-caused resuspension.

Table 4-2. Soil and Underground Contamination Areas at the Hanford Site in 2009.

Hanford Site operational area	Soil contamination areas,^a acres (hectares)	Underground radioactive materials areas,^b acres (hectares)	Interim closed,^c acres (hectares)
100-B, -C	0	72 (29)	42 (17)
100-D, -DR	0	49 (20)	20 (8)
100-F	0	7 (3)	47 (19)
100-H	0	17 (7)	17 (7)
100-K	12 (5)	111 (45)	49 (20)
100-N	2 (1)	40 (16)	64 (26)
200 East ^d	175 (71)	348 (141)	0
200 West ^d	67 (27)	554 (224)	0
300	0	104 (42)	54 (22)
400	0	0	0
600 ^e	8,594 (3,478)	134 (54)	2 (1)
Total ►	8,850 (3,582)	1,436 (581)	296 (120)

^a Includes areas posted as contamination soil contamination or as radiologically controlled and areas that had both underground radioactive material and contamination/soil contamination.

^b Includes areas with only underground contamination.

^c Areas designated as "interim closed" are released from posting requirements when the remedial actions meet the cleanup requirements in the record of decision for that operable unit.

^d Includes tank farms.

^e Includes BC-controlled area, ERDF, and waste disposal facilities outside the 200 East and 200 West Area boundaries.

4.3.2 Description of Specific Fugitive Emission Sources

This section contains brief descriptions of the identified sources of fugitive emissions at the Hanford Site.

4.3.2.1 100 Areas Inactive Reactor Sites

The inactive reactor sites in the 100 Areas include the 100-B/C Area, 100-D Area, 100-F Area, 100-H Area, 100-K Area, and 100-N Area. The reactors are currently under surveillance and maintenance until the long-term disposition of these reactors is determined. Activities were conducted at

several of the reactors to demolish ancillary facilities and to place the reactors in ISS pending final disposition. The potential sources for fugitive emissions include personnel and equipment passing through access doors during surveillance and maintenance; inactive exhaust vents and risers; ISS activities; ancillary facility decontamination and demolition; remedial actions; and characterization activities. Other means of fugitive emissions include erosion, uptake or intrusion of biota, and wind-caused resuspension.

4.3.2.2 100-K Area Basins

Two identical reactors are located in the 100-K Area, one reactor in the 100-KE Area and the other in the 100-KW Area. The reactors and their support facilities were constructed between 1952 and 1954, beginning service in 1955. The 100-KW Area reactor ceased operating in 1970 and the 100-KE reactor in 1971.

The fuel storage basins within the 105-KE and 105-KW Buildings were modified years ago to store N Reactor irradiated fuel. Storing of this fuel began in 1975 at the 105-KE Basin and in 1981 at the 105-KW Basin. In 1989, shipments of fuel from N Reactor to the Basins ceased. The last of the fuel from both basins was removed in 2008. Fuel from the basins was packaged into Multi-Pack Canister Overpacks (MCOs). The MCOs were shipped to CVDF where the fuel is dried. After that, the MCOs, containing the fuel, were shipped to CSB in the 200 East for storage. The primary radionuclides that could be included in fugitive emissions from the 100-K Basins include ^3H , ^{90}Sr , ^{137}Cs , ^{238}Pu , $^{239/240}\text{Pu}$, ^{241}Pu , and ^{241}Am . The potential release points for fugitive emissions include personnel and equipment access doors, which are normally closed.

4.3.2.3 200 Area Facilities and Sites

Active and inactive facilities and sites in the 200 Areas are potential sources for fugitive emissions. Activities in the facilities or on the sites include surveillance and maintenance, decontamination and decommissioning, and stabilization. Erosion, vegetative uptake, wind, and biota intrusion can also induce fugitive emissions at these locations.

4.3.2.4 Plutonium-Uranium Extraction Facility

The PUREX Facility is located in the 200 East Area. The main building, 202-A, is a heavily shielded, reinforced concrete structure known as a canyon. This building contains the main equipment that was used in the PUREX process of chemically separating and purifying actinides from the irradiated nuclear fuel. Radionuclides primarily associated with the PUREX Plant include ^{90}Sr , ^{106}Ru , ^{129}I , ^{137}Cs , ^{238}Pu , $^{239/240}\text{Pu}$, ^{241}Pu , and ^{241}Am . Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.5 Uranium-Trioxide Plant

The UO_3 Plant, located in the 200 West Area, produced UO_3 powder by calcining uranyl nitrate solutions from the PUREX Plant. The UO_3 powder was loaded into hoppers for shipment offsite. Uranium was formerly the potential primary source of radioactive fugitive emissions from the UO_3 Plant. Since the UO_3 Plant was deactivated, only small amounts of UO_3 remain, located primarily inside of equipment. The noble gases radon and thoron remain as the only source of fugitive emissions. Potential fugitive emission release points include access doors, all of which are restricted and controlled.

4.3.2.6 Reduction-Oxidation Plant

REDOX is also located in the 200 West Area. It used methyl isobutyl ketone as a solvent to remove both plutonium and uranium from dissolved fuel rods solutions. Radionuclides primarily associated with REDOX include ^{90}Sr , ^{106}Ru , ^{129}I , ^{137}Cs , ^{238}Pu , $^{239,240}\text{Pu}$, ^{241}Pu , and ^{241}Am . Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.7 Plutonium Finishing Plant

PFM is located in the 200 West Area. It was designed to recover, stabilize, and store plutonium. Recovered plutonium nitrate and plutonium nitrate solutions received from the PUREX Plant were reduced to plutonium dioxide. The reduction process stabilized the plutonium into the state best suited for long-term storage. The current PFM mission does not include producing finished plutonium metal but rather maintaining a safe and compliant facility and engaging in clean-up activities. Radionuclides primarily associated with PFM include $^{239,240}\text{Pu}$, ^{241}Pu , and ^{241}Am . Potential fugitive emission release points from PFM include access doors, passively ventilated spaces, and the inlet-exhaust ventilation system. In May 2009 with the completion of non-CERCLA activities in PFM ventilated spaces, operation of PFM stacks 291-Z-1, 296-Z-5, 296-Z-6 and 296-Z-7 transitioned to CERCLA authority.

4.3.2.7.1 234-5Z Building

The 234-5Z Building is often referred to as PFM, Dash 5, or the 234-5 Building. The basement of the 234-5Z Building mostly consists of pipe tunnels carrying drain piping. The first floor houses the following: (1) two former plutonium processing lines (Remote Mechanical A and Remote Mechanical C Lines) and their control rooms, (2) stabilization and repackaging gloveboxes, (3) plutonium storage vaults, and (4) the plutonium nitrate feed load-in/load-out, blending, and storage facilities. Radionuclides primarily associated with the 234-5Z Building include $^{239,240}\text{Pu}$ and ^{241}Am . Potential fugitive release points include access doors, passively ventilated waste drain line vents, and the inlet-exhaust ventilation system.

4.3.2.7.2 236-Z Building

The 236-Z Building, also called the Plutonium Reclamation Facility, is located south of the southeastern corner of the 234-5Z Building and connected to it by the 242-Z Building. The building air exhausts through the 291-Z-1 stack. Radionuclides primarily associated with the 236-Z Building include $^{239,240}\text{Pu}$ and ^{241}Am . Potential fugitive release points include access doors and the inlet-exhaust ventilation system.

4.3.2.7.3 232-Z Building

The 232-Z Building operated as the Waste Incinerator Facility from the 1960s until 1972 when it was shut down. CERCLA deactivation activities commenced in 2005 and were completed in May 2006. Demolition of the building along with the 296-Z-14 stack was completed in July 2006. Radionuclides primarily associated with the 232-Z Building include $^{239,240}\text{Pu}$ and ^{241}Am . The remaining potential fugitive emission release point is the stabilized building slab.

4.3.2.7.4 241-Z Building

The 241-Z Building is a below-grade reinforced concrete structure with a pre-engineered corrugated metal enclosure over the top that provides weather protection. The below-grade structure consists of five separate ventilated cells, each containing a stainless-steel tank of approximately 17,000-liter capacity. In

addition, the second cell from the west end, the D-7 cell, houses a 700-liter overflow tank. These tanks had been used to accumulate the liquid waste generated during PFP complex operations. The tanks and the vault portion of the 241-Z Building were ventilated by the now-defunct 296-Z-3 Stack. The last waste was transferred out at the end of 2004, and the system has been isolated from PFP processes and from Tank Farms. In 2006, closure activities at 241-Z were completed and CERCLA above-grade deactivation activities begun. The below-grade tanks and cells were cleaned and stabilized. Demolition of the above-grade building along with the 296-Z-3 stack was completed in June 2007. Radionuclides primarily associated with the now-demolished and removed 241-Z Building included $^{239/240}\text{Pu}$ and ^{241}Am . The remaining potential fugitive emission release points are the stabilized below-grade cells.

4.3.2.7.5 242-Z Building

The 242-Z Building houses abandoned waste treatment process equipment once used to recover americium. This facility was permanently shut down after a process upset in 1976 spread contamination and caused irreparable equipment damage inside. The structural integrity of the facility was not compromised, however. The facility was decontaminated extensively before being placed in layaway pending decommissioning work. The 242-Z Building shares the main ventilation system of the 234-5Z and 236-Z Buildings, exhausting its building air through the 291-Z-1 Stack. Radionuclides primarily associated with the 242-Z Building include $^{239/240}\text{Pu}$ and ^{241}Am . Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.7.6 243-Z Building

The 243-Z Building is the Low-Level Waste Treatment Facility, which receives very low-activity wastewater (VLAW) from various PFP operations. The VLAW is treated and then routed to the Treated Effluent Disposal Facility (TEDF). Building air is exhausted through the CERCLA-regulated 296-Z-15 Stack. Radionuclides primarily associated with the 243-Z Building include $^{239/240}\text{Pu}$ and ^{241}Am . Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.7.7 2736-Z and 2736-ZA Buildings

The 2736-Z Building is the primary plutonium storage facility for special nuclear material. The 2736-ZA Building provides ventilation for the 2736-Z Building, emissions from which are exhausted through the 296-Z-6 Stack located on the roof of the 2736-ZA Building. Radionuclides primarily associated with the 2736-Z Building include $^{239/240}\text{Pu}$ and ^{241}Am . Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.7.8 2736-ZB Building

The 2736-ZB Building has a shipping area and receiving area that can both accommodate a maximum of 100 shipping containers, each of which is about the size of a 55-gal (210-L) drum. Adequate spacing is provided between containers to meet criticality prevention requirements, personnel exposure specifications, and corridor access standards to emergency staging areas. The two areas are separated by a wall. The capability to weld inner and outer cans has been added to this building. Exhaust associated with shipping and receiving activities and can-welding operations is ventilated through the 296-Z-5 stack. In addition, the capability to thermally stabilize plutonium-bearing materials in muffle furnaces and repackaging of materials has been added to this building, with associated emissions exhausted through the 296-Z-7 stack. Radionuclides primarily associated with the 2736-ZB Building include $^{239/240}\text{Pu}$ and ^{241}Am . Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.8 T Plant Complex

Originally, the T Plant Complex, then known just as T Plant, was a fuel separations facility using the bismuth-phosphate process. Now the complex is used primarily for repackaging TRU and TRU mixed waste for eventual shipment to the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. Other waste activities include cleaning radioactively contaminated equipment and storing, treating, sampling, and verifying waste.

The T Plant Complex is located in the 200 West Area. Buildings, structures, or special facilities in the Complex are the 221-T Building (Canyon, Head-End, and Railroad Tunnel); the 2706-T, 2706-TA, and 2706-TB Buildings; the 214-T Storage Building; storage modules; and outdoor treatment and storage pads. Other ancillary structures, buildings, and areas include the 271-T administration building, 291-T-1 stack, 221-TA Buildings, and 211-T Area.

Decontamination processes, storage, and treatment are conducted in the 221-T Building and 2706-T Building and other locations within the T Plant Complex boundary. The 221-T Building Head-End is used for waste processing activities (e.g., treatment and storage). The 271-T Building and other support structures provide office space to staff supporting T Plant operations.

Radioactive decontamination, treatment, and storage activities are performed on the canyon deck, process cells, railroad tunnel, and head-end. The canyon area consists of 37 cells and one railroad tunnel door. The railroad tunnel, used for transporting equipment, waste, etc., into and out of the canyon, enters the plant at cell 2L. A motor-driven rolling steel door provides railroad tunnel access. Primary radionuclides associated with T Plant include ^{90}Sr , ^{137}Cs , and $^{239,240}\text{Pu}$. Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.8.1 2706-T Building

The 2706-T Building is a ground-level structure constructed of prefabricated steel. Two openings on its west end are fitted with roll-up metal doors that allow access to the pit area. Treatment, storage, and low-level radioactive decontamination activities can be performed over this pit. Radionuclides primarily associated with the 2706-T Building include ^{90}Sr , ^{137}Cs , $^{239,240}\text{Pu}$, and ^{241}Am . Potential fugitive emission release points include access doors, the inlet-exhaust ventilation system, and an outdoor storage area.

4.3.2.8.2 221-T Building — Head-End Operations

The 221-T Building head-end consists of a canyon area extending from the basement floor to the roof. This canyon area has several deck levels and a parapet wall. Four floor levels adjacent to the canyon house include (1) an electrical switchgear room, (2) a chemistry laboratory, (3) office areas, (4) a change room, (5) a lunch room, (6) a control room, (7) an instrument shop, (8) a maintenance shop, and (9) storage areas. Radionuclides primarily associated with 221-T Head-End Operations include ^{90}Sr , ^{137}Cs , and $^{239,240}\text{Pu}$. Potential fugitive emission release points include access doors and inlet-exhaust ventilation system.

4.3.2.8.3 221-T Building — Pressurized-Water Reactor Fuel Assembly Storage

Canyon cell 2R was modified to include a fuel pool for storing 72 pressurized-water reactor (PWR) Core 2 blanket fuel assemblies, used in the Shippingport Reactor. By the end of September 2004, those fuel assemblies had all been removed from the pool and shipped to the CSB.

The 221-T Building galleries are maintained at atmospheric pressure, while the 221-T Building canyon area is kept at a negative pressure with respect to other connected ventilated spaces. A primary design feature of these systems is to ensure that potentially contaminated canyon air is completely separate from the clean air in the 221-T Building galleries and the 271-T Building, which is the office space connected to the 221-T Building.

The 271-T Building is adjacent to the 221-T Building. While most of this building is used for office space, portions are used by T Plant Complex Operations. Radionuclides primarily associated with 221-T-PWR Fuel Assembly Storage include ^{90}Sr , ^{137}Cs , and $^{239/240}\text{Pu}$. Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.9 B Plant Complex

Currently, the B Plant Complex is deactivated and all production activities have ceased. It was originally designed to chemically process spent nuclear fuels. Radiological containment and confinement features were incorporated in the various facilities and support systems to prevent exposure of plant personnel and the general public to excessive radiation. The plant was then modified to separate strontium and cesium from the fission product waste stream following plutonium and uranium recovery from irradiated reactor fuels in the PUREX Plant. The recovered purified and concentrated strontium and cesium solutions were then transferred to WESF for conversion to solid compounds, encapsulation, and interim storage. After strontium and cesium removal, the remaining waste was transferred from B Plant to the Tank Farms.

B Plant consists of the 221-B Processing Building and the 271-B Service and Office Building. The 221-B Process Building and its attached 271-B Service Building were constructed in 1943. Radionuclides primarily associated with B Plant include ^{90}Sr and ^{137}Cs . Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.10 Waste Encapsulation and Storage Facility

WESF, or the 225-B Building, is an operating facility used to ensure safe storage and management of the cesium and strontium capsules. Construction of WESF was completed in 1974. Radionuclides primarily associated with WESF include ^{90}Sr and ^{137}Cs . Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.11 200 Area Interim Storage Area (at CSB)

The 200 Area Interim Storage Area (ISA) is located adjacent to CSB. The ISA is designed to receive non-defense reactor spent nuclear fuel (SNF) from various locations at the Hanford Site for consolidated interim storage. The SNF intended for relocating to the ISA included SNF from FFTF, the Neutron Radiography Facility, and light-water reactors whose fuel has been transferred to DOE for research. The ISA is periodically monitored by means of hand-held radiation-detection instruments used to check for the presence of radiological contamination on swipes collected on the outer surfaces of containers holding SNF.

4.3.2.12 222-S Laboratory Complex

The 222-S Laboratory Complex is located near the southeast corner of the 200 West Area. The facility is composed of the main laboratory complex (222-S) and a number of ancillary buildings and structures.

4.3.2.12.1 222-S Laboratory

The 222-S Laboratory is a two-story, aboveground building with a subterranean service level. This building is divided into laboratory support spaces, office spaces, a multi-curie wing, a hot cell addition, and supplemental service areas. The building is designed with its own waste disposal facility, decontamination facility, fire protection and alarm system, ventilation system, and radiation monitoring systems.

The 222-S Laboratory Annex houses the maintenance shop, instrument shop, and the counting room filter building. Radionuclides primarily associated with the 222-S Laboratory include ^{90}Sr , ^{137}Cs , and $^{239,240}\text{Pu}$. Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.12.2 222-SA Laboratory

The 222-SA Laboratory is a five-wide modular building located southeast of the 222-S Laboratory. Part of this laboratory prepares nonradioactive standards for 222-S and other Hanford Site laboratories. The other section of the laboratory is used for cold-process development work and standards preparation. The 222-SA Laboratory only has the potential for nonradioactive fugitive emissions.

4.3.2.12.3 2716-S Storage Building

The 2716-S Storage Building, located south of the 222-S Laboratory, is partitioned off for the storage of acids and bases. It provides both long- and short-term storage capability for laboratory materials and contains no radioactive materials.

4.3.2.12.4 207-SL Retention Basin

The 207-SL Retention Basin acts as a temporary holding facility for nonradioactive, nonhazardous liquid effluents before they are transferred via a cross-site pipeline to the TEDF, located in the 200 East Area. Transfers are also done by means of tanker truck, which transports basin water to the Liquid Effluent Retention Facility if the wastewater does not meet TEDF acceptance criteria.

The basin is a covered, below-grade concrete structure, directly northeast of the 222-S Building. Two 25,000-gal (95,000-L) compartments allow batch collection, sampling, and discharge of the wastewater. Three 20,000-gal (75,708-L) storage tanks were added in 1994 to improve waste transfer and storage capabilities. Wastewater from the laboratory, normally free of radioactive and hazardous chemical contamination, is routed to the 207-SL Retention Basin. Nonradioactive, nonhazardous wastewater from the nearby package boiler is also discharged to the basin. Radionuclides primarily associated with the 207-SL Retention Basin include ^{90}Sr , ^{137}Cs , and $^{239,240}\text{Pu}$. Potential fugitive release points include access doors and seams in the basin cover blocks.

4.3.2.12.5 219-S Waste Handling Facility

The 219-S Waste Handling Facility collects liquid waste generated by the 222-S Laboratory operations that is contaminated radioactively and/or with hazardous chemicals. Potential fugitive release points include access doors in the enclosure facility over the vaults. This facility consists of two below-grade vaults (A and B, also called cells) containing three stainless steel tanks, a Transite (a product of BNZ Materials, Inc.) building, the pipe trench and operating gallery, and an attached concrete-walled sample gallery. Tanks TK-101 and TK-102 are in vault A and tanks TK-103 and TK-104 are in vault B. Tank TK-103 is no longer in service. Radionuclides primarily associated with the 219-S Waste Handling

Facility include ^{90}Sr , ^{137}Cs , and $^{239/240}\text{Pu}$. Potential fugitive release points include access doors and seams in the vault enclosure.

4.3.2.12.6 222-SB Filter Building

The 222-SB Filter Building, located south of the 222-S Building, houses 96 HEPA filters, which provide final filtration for the 222-S Laboratory. Under normal operation of the ventilation system, three electrically powered fans exhaust air from the 222-S Laboratory. Exhaust air leaves the 222-S Building through the 296-S-21 stack. In the event one of the primary exhaust fans fails to operate, emergency diesel-powered ventilation is provided for and exhausted through the 222-SE Filter Building. Radionuclides primarily associated with the 222-SB Filter Building include ^{90}Sr , ^{137}Cs , and $^{239/240}\text{Pu}$. Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.12.7 222-SC Filter Building

The 222-SC Filter Building, located north of the 222-S Laboratory, contains the second and third stage HEPA filtration for hot cells 1-A, 1-E-1, 1-E-2, 1-F, and 11-A-1 through 11-A-6. The hot cells in rooms 1-A, 1-E, 1-E, 1-F, and 11-A are serviced by the main building supply and exhaust ventilation. The 222-SC Filter Building houses five parallel pairs of HEPA filters, which provide filtration to hot cell exhaust air before it enters the main exhaust plenum and final filtering in the 222-SB or 222-SE Filter Buildings. A total of three stages of HEPA filtration are provided for the hot cell ventilation exhaust.

4.3.2.12.8 222-SE Filter Building

The 222-SE Filter Building, located south of the 222-S Building, houses 56 HEPA filters. This building provides redundant backup filtering capabilities for the 222-S Laboratory exhaust. Radionuclides primarily associated with the 222-SE Filter Building include ^{90}Sr , ^{137}Cs , and $^{239/240}\text{Pu}$. Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.12.9 218-W-7 Dry Waste Burial Vault

The 218-W-7 Dry Waste Burial Vault is located 40 ft (11.3 m) southeast of 222-S. This underground concrete vault was removed from service around 1960. It was used primarily for disposal of plutonium-contaminated hood waste generated by the 222-S Laboratory. Access to the tank is through a locked hatchway. The radionuclide primarily associated with the 218-W-7 Dry Waste Burial Vault is $^{239/240}\text{Pu}$. A locked access hatchway is the only potential release point for fugitive emissions.

4.3.2.13 Waste Verification and Sampling Facility

The Waste Verification and Sampling Facility (213-W Building) is located in the 200 West Area. The 213-W Building is adjacent to the 272-WA Building (the Operations Support Building) at the 218-W-5 Burial Grounds at the west end of the 200 West Area. The primary function or process associated with this facility is the verification of waste drums received from waste generators. Because of limited use, it was transferred to the 200 West Tank Farms in 1995. Radionuclides primarily associated with the 213-W Building include low levels of ^{90}Sr and ^{137}Cs . Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.14 Waste Receiving and Processing Facility

WRAP, initially constructed and operational in 1997, has expanded to a group of structures on the west side of the 200 West Area adjacent to CWC. It is used for examining, assaying, characterizing, and

repackaging principally TRU waste destined for disposal at the WIPP in Carlsbad, New Mexico. Some rooms in the building are dedicated to mechanical, electrical, heating, ventilating, and cooling systems, as well as to administrative areas.

4.3.2.15 Central Waste Complex

CWC is a group of structures located on the west side of the 200 West Area exclusion zone, consisting of the Flammable and Alkali Metal Waste Storage Modules; Waste Storage Buildings; Waste Storage Pad; outdoor storage areas; and Waste Receiving and Staging Area. The primary function or process associated with the CWC is the receipt and storage of radioactive and mixed waste. The CWC has the potential to generate radioactive and/or hazardous chemical emissions and radioactive and/or hazardous chemical liquid effluent. Radionuclides associated with the CWC are from a wide group of mixed-fission, mixed-waste, and TRU radionuclides. Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.15.1 Flammable and Alkali Metal Waste Storage Modules

The Flammable and Alkali Waste Storage Modules are pre-engineered structures. The size and weight of the storage modules vary, depending on the manufacturer. As a result, no set standard exists for every module. The front, back, and side walls of all of these modules are constructed of 10-gauge steel and coated inside with chemical-resistant epoxy paint or have a corrosion-resistant covering. All roofs are constructed of 12-gauge steel. All modules have a vented catch sump under their storage floors. Each sump has a capacity of 400 to 2,000 gal (1,500 to 7,600 L). Water supply presently is not provided but could be if necessary. Under no circumstances would water be provided to the Alkali Metal Waste Storage Modules.

4.3.2.15.2 2401-W Waste Storage Building

The 2401-W Waste Storage Building is a pre-engineered steel structure for housing dangerous, mixed, radioactive, and/or Toxic Substances Control Act of 1976 (TSCA) waste. It is 50 ft (15.2 m) wide by 80 ft (24.4 m) long by 20 ft (6.1 m) high. It is maintained at atmospheric pressure, and heating and cooling are not required for its operations.

4.3.2.15.3 2402-W Buildings

The 2402-W Buildings are pre-engineered steel structures for housing dangerous, mixed, radioactive, and/or TSCA waste. They are 50 ft (15.2 m) wide by 80 ft (24.4 m) long by 20 ft (6.1 m) high. They are maintained at atmospheric pressure, and heating and cooling are not required for their operations.

4.3.2.15.4 2403-WA through 2403-WC Waste Storage Buildings

These buildings are pre-engineered steel structures for housing dangerous, mixed, radioactive, and/or TSCA waste. They are 170 ft (51.8 m) wide by 200 ft (61 m) long by 20 ft (6.1 m) high and are maintained at atmospheric pressure. Heating and cooling are not required for their operations.

4.3.2.15.5 2403-WD Waste Storage Building

This building is a pre-engineered steel structure for housing dangerous, mixed, radioactive, and/or TSCA waste. It is 170 ft (51.8 m) wide by 275 ft (99 m) long by 20 ft (6.1 m) high. It is maintained at atmospheric pressure, and heating and cooling are not required for its operations.

4.3.2.15.6 Waste Receiving and Staging Area

This area is an asphalt pad approximately 61 m long and 46 m wide, and is used for container handling and staging of waste destined for various storage buildings.

4.3.2.15.7 2404-W Waste Storage Buildings

The 2404-W Buildings are pre-engineered steel structures for housing dangerous, mixed, radioactive, and/or TSCA waste. They are 121.2 ft (37 m) wide by 180.4 ft (55 m) long by 20 ft (6.1 m) high and maintained at atmospheric pressure. Heating and cooling are not required.

4.3.2.15.8 Waste Storage Pad

The waste storage pad is approximately 90 ft (27.4 m) by 100 ft (30.5 m) with a 6 in. (15.2 cm) curb and has an access ramp and rainwater collection-and-removal system.

4.3.2.16 Tank Farms

Liquid waste from chemical processing operations containing high concentrations of radionuclides is stored on an interim basis in underground tanks. The Hanford Site Tank Farms contain 177 tanks (149 SSTs and 28 DSTs) with capacities ranging from 50,000 to 1.2 million gal (190,000 to 4.5 million L). Since 1967, newly generated liquid waste has been stored in DSTs. The SSTs are no longer receiving waste.

The location of all the Tank Farms is the 200 East and 200 West Areas. Both DSTs and SSTs are present in these areas. Tank Farms in the 200 East Area include the A, AX, B, BX, BY, C (SSTs), AN, AZ, AY, AP, and AW (DSTs). Those in the 200 West Area are the S, SX, T, TX, TY, U (SSTs) and the SY (DST). Hanford Site Tank Farms comprise transfer routes, diversion boxes, storage vaults, double-contained receiver tanks (DCRTs), and evaporators.

A system of underground pipes is used to transfer wastes from the 200 West Area DSTs to the 200 East Area DSTs, as well as between the DSTs and from the DSTs to treatment and storage units in the 200 East Area. Underground and "at-grade" pipe systems are used to transfer waste from SSTs into the DSTs.

Radionuclides currently analyzed for in sampled emissions from the Tank Farms include ^{90}Sr , ^{125}Sb , ^{129}I , ^{137}Cs , ^{239}Pu , and ^{241}Am . Fugitive emission release locations may include vents, risers, access hole covers, inlet-exhaust ventilation systems, diversion boxes, transfer lines, and storage vaults.

4.3.2.16.1 Double-Shell Waste Tanks

The DSTs are of two different types. The first type has a capacity of one million to 1.2 million gal (3.79 million to 4.54 million L) and is used for long-term storage of high-activity mixed waste. Twenty-four 1.2-million-gal (4.5-million-L) DSTs and four 1.0-million-gal (3.8-million-L) DSTs have been built. For efficiency during construction and operation, these tanks were grouped into six Tank Farms.

The second type of DST is smaller, with storage capacities ranging from 800 to 45,000 gal (3,028 to 170,370 L). These tanks were used primarily for lag storage of waste before transfer to the larger tanks or to other facilities. These smaller tanks are called DCRTs.

The first type of DSTs was fabricated as three concentric tanks with an annular area between the inner primary steel tank and the outer secondary steel tank. A concrete tank encloses the secondary tank and the roof of the primary tank. A DST tank farm consists of 2 to 8 tanks. The second type of DSTs consists of a steel tank situated within a concrete vault. The vault also provides an annular-type space around the tank. Ancillary equipment also is present, such as transfer lines, valve pits, diversion boxes, and tank-farm piping. Fugitive emissions can occur from the ancillary equipment and from the DST primary tanks and annuli if the powered ventilation is not operating.

4.3.2.17 242-A Evaporator

The 242-A Evaporator complex is located in the 200 East Area. The 242-A Building contains the evaporator vessel and supporting process equipment. Separate ventilation systems are used for the evaporator vessel and the building. Radioactive emissions are monitored at the stack of each ventilation system. Radionuclides currently analyzed for in sampled emissions from 242-A include ^{90}Sr , ^{129}I , ^{137}Cs , $^{239,240}\text{Pu}$, and ^{241}Am . Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.18 242-S Evaporator

The 242-S Evaporator, currently inactive, is located in the 200 West Area. It consists of an evaporator vessel, supporting process equipment, and control area. The building ventilation exhausts filtered building air. Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.19 242-T Evaporator

The 242-T Evaporator, currently inactive, is located in the 200 West Area. The 242-T Evaporator Facility is divided into a processing area and a control area. The process area includes the 242-T Building, the 242-TA Vault, and 242-TB Ventilation Building. The control area is contained in the metal building adjacent to the east wall of the 242-T Building. Potential fugitive emission release points include access doors and the inlet-exhaust ventilation system.

4.3.2.20 Grout Treatment Facility (GTF)

GTF combined low-level radioactive liquid waste with a cement mixture that was pumped into disposal vaults. GTF was placed in cold standby in 1993. Radioactive constituents primarily associated with GTF include ^{90}Sr , ^{137}Cs , and other low-level radioactive waste from the Tank Farms. Potential fugitive emission release modes include vents, risers, and the inlet-exhaust ventilation system.

4.3.2.21 Low-Level Burial Grounds and Environmental Restoration Disposal Facility

The LLBG is an active land-based unit consisting of eight burial grounds located in the 200 East and 200 West Areas. The 218-E-10 and 218-E-12B Burial Grounds are in the 200 East Area. The 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5, and 218-W-6 Burial Grounds are in the 200 West Area. The LLBG are of various sizes and depths of lined and unlined disposal trenches. The lined trenches have leachate collection and removal systems.

The following provides a brief description of waste disposed of in the LLBG. An electronic database is maintained that documents each waste receipt, type of waste, and disposal location. Waste disposal in unlined trenches ceased in calendar year 2003. The only trenches that continue to receive waste are

trench 94, used for defueled naval reactor compartments, in burial ground 218-E-12B and trenches 31 and 34, used for mixed waste, in burial ground 218-W-5.

4.3.2.21.1 Burial Ground 218-W-3A

Burial Ground 218-W-3A is approximately 50 acres (20.4 hectares) in size and began receiving waste in 1970. Examples of waste received in this burial ground include ion-exchange resins, failed equipment, tanks, pumps, ovens, agitators, heaters, hoods, jumpers, vehicles, accessories, retrievable TRU waste, and post-August 19, 1987-RCRA and state-only designated mixed waste.

4.3.2.21.2 Burial Ground 218-W-3AE

The 218-W-3AE Burial Ground is approximately 49 acres (20 hectares) in size and began receiving waste in 1981. Examples of waste received in this burial ground include rags, paper, rubber gloves, disposable supplies, broken tools, and post-August 19, 1987-RCRA and state-only designated mixed waste.

4.3.2.21.3 Burial Ground 218-W-4B

The 218-W-4B Burial Ground is approximately 8.6 acres (3.5 hectares) in size and began receiving waste in 1968. Examples of waste received in this burial ground include rags, paper, rubber gloves, disposable supplies, broken tools, and retrievable TRU waste.

4.3.2.21.4 Burial Ground 218-W-4C

The 218-W-4C Burial Ground is approximately 49 acres (20 hectares) in size and began receiving waste in 1978. Examples of waste received in this burial ground include contaminated soil, decommissioned pumps, pressure vessels, post-August 19, 1987-RCRA and state-only designated waste, and retrievable TRU waste.

4.3.2.21.5 Burial Ground 218-W-5

The 218-W-5 Burial Ground is approximately 92 acres (37.2 hectares) in size and began receiving waste in 1986. Examples of waste placed in this burial ground include rags, paper, rubber gloves, disposable supplies, broken tools, and post-August 19, 1987-RCRA and state-only designated waste. It currently contains double-lined mixed-waste trenches (trenches 31 and 34). Trenches 31 and 34 also are designated for greater-than-90-day container storage. Waste to be placed in trenches 31 and 34 for storage purposes predominately will be macro-encapsulated long-length contaminated equipment and other containerized waste that has been treated to meet Land Disposal Restriction (LDR) requirements. Adjacent to the double-lined mixed-waste trenches are leachate collection tanks. Examples of waste to be placed in the double-lined mixed-waste trenches include mixed waste that has been treated to meet LDR requirements (including bulk waste), macro-encapsulated long-length contaminated equipment, etc.

4.3.2.21.6 Burial Ground 218-W-6

The 218-W-6 Burial Ground is approximately 40 acres (16 hectares) in size and has not received any waste.

4.3.2.21.7 Burial Ground 218-E-10

The 218-E-10 Burial Ground is approximately 89 acres (36 hectares) in size and began receiving waste in 1960. Examples of waste located there are failed equipment, rags, paper, rubber gloves, disposable supplies, broken tools, and post-August 19, 1987-RCRA and state-only designated mixed waste.

4.3.2.21.8 Burial Ground 218-E-12B

Burial Ground 218-E-12B is approximately 168 acres (68 hectares) in size and began receiving wastes in 1967. Examples of waste placed in the burial ground include defueled reactor compartments (trench 94), low-level waste, and retrievable TRU waste.

4.3.2.22 Environmental Restoration Disposal Facility

ERDF opened in July 1996 and received waste from Environmental Restoration activities across the Hanford Site. The ERDF consists of cells equipped with a double liner and leachate collection and recovery system that meets the requirements for hazardous waste landfills under RCRA. The ERDF is authorized under a CERCLA record of decision and can only receive waste from actions conducted on the Hanford Site. An interim cover of soil is placed over the cells until the final closure cover is constructed.

4.3.2.23 300 Area Fuel Supply Facility

The buildings previously associated with the 300 Area Fuel Supply Shutdown Facility have been demolished. The associated inactive waste transfer system will be addressed under the CERCLA action for the 300-FF-2 Operable Unit.

4.3.2.24 340 Complex

The 340 Complex is located in the 300 Area near the Columbia River. The 340 Complex was constructed primarily to collect, store, and transport radioactive liquid wastes from 300 Area facilities. Waste was sent from the 324, 325, 326, 327, and 329 Buildings to the Radioactive Liquid Waste System until its valves were closed and most lines cut and capped at their sources. Direct shipments of containers or tankers were also received at the 340 Facility and added to the vault tanks. The 340 Complex also includes the 300 Area Retention Process Sewer, which collects process wastewater with the potential to become radioactively contaminated. This waste stream is monitored for radioactive materials and then accumulated in the 307 Basins before being transferred to the 300 Area TEF for treatment.

Uranium, ^{60}Co , ^{90}Sr , ^{137}Cs , ^{238}Pu , $^{239,240}\text{Pu}$, and ^{241}Am are the most significant radionuclides potentially present at the 340 Complex. Potential fugitive emission release points include access doors, the inlet-exhaust ventilation system, and the 307 Retention Basin.

4.3.2.24.1 340-A Building

The 340-A Building houses six aboveground storage tanks, which provided temporary storage of radioactive liquid waste. The 340-NT-EX Stack powered exhaust system provides airborne ventilation to the now empty storage tanks, and the 340-A Building air is passively ventilated to the atmosphere via a roof air vent. Smearable radiological contamination resulting from leakage of radioactive liquid waste from the storage tanks has been detected in the 340-A Building. The radionuclides with the most significant dose impact include ^{90}Sr , ^{137}Cs , ^{238}Pu , $^{239,240}\text{Pu}$, and ^{241}Am , which could potentially be present in fugitive emissions from the facility.

4.3.2.24.2 340-B East Building

The 340-B East Building served as a railroad car load-out facility. This facility housed railroad cars during the transfer of radioactive liquid wastes from the 340 vault tanks. The 340-B East Building exhaust system is currently not operated, thus the building is not maintained at negative pressure. Consequently, fugitive emissions can potentially occur. Potential fugitive emission release points at the 340-B East Building include personnel and equipment access doors. The radionuclides with the largest dose impact that potentially could be released as fugitive emissions include ^{90}Sr , ^{137}Cs , ^{238}Pu , $^{239,240}\text{Pu}$, and ^{241}Am .

4.3.2.24.3 340 Vault

The 340 Vault houses two 15,000-gal (57,000-L) radioactive mixed tanks that accumulated mixed waste for shipment to the 200 Area TSD facilities. The 340 Vault, the vault tanks, and the associated piping system are ventilated through the 340-NT-EX stack. Smearable and fixed contamination resulting from tank overfills and maintenance activities are documented in facility records.

4.3.2.24.4 Retention Process Sewer

The Retention Process Sewer consists of a plumbing system, a liquid waste retention/storage system, and a monitoring system. The plumbing system consists of underground single-walled pipes and unsealed manholes that transport liquid waste from the generating facilities to the liquid waste retention/storage system. The retention system consists of four lined and connected open-top concrete basins, which are also known as the 307 Retention Basins. Each basin has a holding capacity of approximately 25,000 gal (95,000 L). The monitoring system uses in-line gamma radiation detectors to monitor radiation levels in the liquids of the Retention Process Sewer. The gamma detectors are used to divert potentially contaminated wastewater to one of the 307 Basins for further evaluation. If contamination is detected above specified action levels, the wastewater can be filtered to meet acceptance levels of the 300 Area TEDF, or if necessary trucked to the 200 Area for treatment and disposal.

4.3.2.25 361 Building Modular Equipment Shelter

The Modular Equipment Shelter is a pre-cast concrete portable equipment shelter permanently located in the southeast corner of the 300 Area. Sampling equipment is installed to sample atmospheric gases, some of which may be radioactive. Periodically, radioactive xenon and/or radon calibration gas is used to confirm operability of the equipment. The building has no active ventilation or exhaust point. The 361 Building is capable of handling sealed sources, which are subject to limitations. Only radioxenon and ^{222}Rn -calibration sources are allowed for temporary use. Other unsealed radioactive materials are not allowed in the building. Emissions from the Modular Equipment Shelter are fugitive in nature.

4.3.2.26 Fast Flux Test Facility

Deactivation of FFTF was completed in June 2009. FFTF had been a 400-megawatt-thermal, sodium-cooled, fast-neutron-flux reactor designed specifically for irradiation testing of nuclear reactor fuels and materials for liquid-metal, fast-breeder reactors. Radionuclides primarily associated with FFTF include ^3H and ^{137}Cs . The potential primary fugitive emission release points include the personnel and equipment access doors and the inlet-exhaust ventilation system.

4.3.2.27 Waste Sampling and Characterization Facility Ancillary Facilities

4.3.2.27.1 6265A Building

The Solid Waste Storage Area (6265A Building) is an open-sided, outdoor, 90-Day Accumulation Area used for temporary storage of drums or other low-level radioactive waste packages.

4.3.2.27.2 6266A Building

The Contaminated Liquid Retention Vault (6266A Building) contains two 3,785-liter polyethylene tanks in a common concrete vault. The tanks were designed to receive low-level inorganic, radiologically contaminated liquid waste or sample excess from the analytical laboratory. The liquid is transferred to an approved disposal facility on the Hanford Site using a portable tank truck. This building also provides temporary storage of drums or other low-level radioactive waste packages.

4.3.2.27.3 6267 Building

The Environmental Sample Archive Building (6267 Building) provides for controlled storage, indexing, categorizing, and retrieval of low-level radiological samples. Storage is provided for up to 2,500 samples requiring refrigerated storage and up to 11,500 samples requiring ambient storage. This building also provides for temporary storage of drums and other low-level radioactive waste packages.

4.3.2.27.4 6268 Building

The Sample Equipment Cleaning Facility (6268 Building) provides cleaning for the various tools used for collecting samples from the field. The tools are scrubbed and given solvent and acid baths to clean residual chemicals. No radioactive materials are allowed in this building. Administrative controls are in place to prevent any radioactive materials from entering the building.

4.3.2.27.5 6269 Building

The Mobile Laboratory Storage Facility (6269 Building) houses up to five mobile laboratories and provides protection from adverse weather conditions for the instrumentation and computers contained inside the laboratories. This area also contains calibration laboratory instrumentation used in the mobile laboratories and a sample preparation area for adding chemical buffers and preservatives to sample containers. The building also provides temporary storage of drums or other low-level radioactive waste packages.

4.3.2.27.6 6270 Building

The Environmental Data/Remedial Tracking System Facility (6270 Building) provides accommodations for computerized records data processing to retain records of sample inventories, tracking data, and sample analysis data. This facility is nonradioactive and is used primarily to house administrative personnel.

4.3.2.28 Purgewater Storage Tanks

Purgewater Modutanks, located in the 600 Area but near the 200 Areas, store and treat groundwater purged from Hanford wells. The tanks, each with a one-million-gallon capacity, are located aboveground, double-lined, and open to the atmosphere.

5.0 SUPPLEMENTAL INFORMATION

This section has supplemental information related to Hanford Site radionuclide air emissions in 2009 and consists of the following:

- Population dose estimate
- Compliance status with Subparts Q and T of 40 CFR 61
- Radionuclide emission estimates and periodic confirmatory measurement information related to NOCs
- Ambient air sampling measurements
- Quality assurance (QA) program status of compliance with 40 CFR 61, Appendix B, Method 114.

5.1 POPULATION DOSE ESTIMATE

The estimated regional population radiation dose (i.e., the collective EDE) from Hanford Site air emissions in 2009 was calculated using the GENII computer code (PNL-6584, *GENII – The Hanford Environmental Radiation Dosimetry Software System*). In earlier years, GENII version 1.485 was used to calculate doses. For 2009, GENII version 2.09 (PNNL-14583, *GENII Version 2 Users' Guide*) was used. Version 2.09 results include implementation of some updated environmental modeling and ICRP 60 weighting factors. The population consisted of approximately 486,000 people residing within a 50-mi (80-km) radius of the Hanford Meteorology Station, which is located near the center of the Hanford Site (PNNL-14428, *Hanford Area 2000 Population*). The population within 50 mi (80 km) of sources in the 300 Area, which account for over 90 percent of the collective dose from air pathways, is about 350,000. Pathways evaluated for population exposure to releases of radionuclides from the Hanford Site to the atmosphere include inhalation, air submersion, ground-shine, and consumption of food. Population exposure to radionuclide air emissions was determined using values of population-weighted atmospheric dispersion factors for each distance and compass sector.

The collective EDE for 2009 from radionuclide air emissions was 0.32 person-rem (0.0032 person-Sv). Radionuclide releases from the Hanford Site to surface water added 0.68 person-rem (0.0068 person-Sv). Therefore, the total population dose in 2009 from both airborne and liquid-borne radionuclides originating from the Hanford Site was 1.0 person-rem (0.010 person-Sv).

5.2 COMPLIANCE STATUS WITH 40 CFR 61, SUBPARTS Q AND T

In 40 CFR 61, Subpart Q, "National Emission Standards for Radon Emissions From Department of Energy Facilities," paragraph 61.190 states that the provisions of Subpart Q apply to the design and operation of all storage and disposal facilities for radium-bearing material that emit ^{222}Rn to the air. Paragraph 61.191(b) states that a source means any building, structure, pile, impoundment, or area used for interim storage or disposal that is or contains waste material containing radium in sufficient concentration to emit ^{222}Rn in excess of a standard of 20 pCi/m²/s. The known quantities of ^{226}Ra (the immediate precursor to ^{222}Rn) stored at the Hanford Site were evaluated and found to decay to ^{222}Rn at a rate below the standard.

Activities at the Hanford Site were evaluated for compliance with 40 CFR 61 Subpart T, "National Emission Standards for Radon Emissions From the Disposal of Uranium Mill Tailings." In paragraph 61.220, "Designation of Facilities," owners and operators of such facilities are subject to the provisions in Subpart T: those whose sites were used for the disposal of tailings and that managed residual radioactive material or uranium byproduct materials during and following the processing of

uranium ores and that are listed in or designated by the Secretary of Energy under Title I of the Uranium Mill Tailings Control Act of 1978 or regulated under Title II of that act. Since no uranium milling and uranium-ore processing activities are conducted at the Hanford Site, Subpart T does not apply.

5.3 EMISSION ESTIMATES AND PERIODIC CONFIRMATORY MEASUREMENT DATA FOR NOTICES OF CONSTRUCTION

This section contains emission estimates and periodic confirmatory measurement data as required by NOC's and other regulatory agreements.

5.3.1 Site-wide Notices of Construction for Portable Exhausters

This section contains information on portable exhausters covered by site-wide NOCs. Portable exhausters are referenced in *Radioactive Air Emissions Notice of Construction Portable/Temporary Radioactive Air Emission Units* (DOE/RL-96-75, Rev. 2) and in *Radioactive Air Emissions Notice of Construction for HEPA Filtered Vacuum Radioactive Air Emission Units* (DOE/RL-97-50, Rev. 2), which require that the estimated emissions from these units be summarized in this document. The information in Tables 5-1 and 5-2 fulfills that requirement.

When yearly documentation demonstrates that the handling limits for the emission units have not been exceeded, the estimated emissions are considered to be equal to or less than the values provided in the respective NOC.

Table 5-1. Emission Estimates for Portable/Temporary Radioactive Air Emission Units in 2009

Unit Type	Radionuclide	Annual estimated emissions, Ci
Type I Units	¹³⁷ Cs	2.92 E-07 ^a
Type II Units		did not operate
Type III Units		did not operate

1 Ci = 1 curie = 3.7 E+10 becquerels (Bq)

^a Emissions in 2009 were summarized by calculating a ratio of the total hours of operation during that year (37.25 hr/8,760 hr/yr) to the annual abated release limit (i.e., 6.86 E-05 Ci/yr) in DOE/RL-96-75, Rev. 2, to obtain emissions represented by the hours of operation.

Table 5-2. HEPA-Filtered Vacuum Usage for 2009

Facility	Area	Alpha possession quantity, NOC limit, Ci	Beta-gamma possession quantity, NOC limit, Ci	Alpha possession quantity in 2009, Ci	Beta-gamma possession quantity in 2009, Ci	Estimated Actual Emissions, Ci	
						Alpha	Beta-gamma
222-S	200-W	7.70 E-03	3.88 E-01	1.44 E-06	2.78 E-07	7.20 E-10	1.39 E-10
219-S	200-W	7.70 E-03	3.88 E-01	0	1.40 E-15	0	7.00 E-19
ETF	200-E	4.57 E-03	2.30 E-01	<9.89 E-09	<4.95 E-07	<4.95 E-12	<2.48 E-10

1 Ci = 1 curie = 3.7 E+10 becquerels (Bq).

ETF = Effluent Treatment Facility

5.3.2 Miscellaneous Periodic Confirmatory Emission Measurements

Table 5-3 shows information that confirms low emissions, as verified by results from nondestructive analysis of HEPA filters.

Table 5-3. Nondestructive Analysis Results for 2009

Location	Filtration	Analysis date	Radionuclide	μCi
296-S-23 Stack	HEPA (primary stage)	5/13/09	¹³⁷ Cs	≤0.23
Guzzler	HEPA	10/27/09	¹³⁷ Cs	0

1 Ci = 1 curie = 3.7 E+10 becquerels (Bq); HEPA = high-efficiency particulate air.
NA = not applicable

Table 5-4 shows information that confirms low emissions, as verified by results from destructive analysis of a K Basins Closure Project HEPA filter.

Table 5-4. K Basins Closure Project Destructive Analysis Results for 2009

Stack (Location; EDP code)	Filter medium	Radionuclides or type of radioactivity	Activity, pCi
105-KW Air Sparging Vent (105-KW Basin; Y249)	HEPA	⁹⁰ Sr	ND
		¹³⁷ Cs	ND
		²³⁸ Pu	5.7 E+01
		^{239,240} Pu	ND
		²⁴¹ Pu	ND
		²⁴¹ Am	5.5 E+00
		gross α	ND
		gross β	4.9 E+03

ND = not detected; HEPA = high-efficiency particulate air.
1 Ci = 1 curie = 3.7 E+10 becquerels (Bq).

5.3.3 Periodic Confirmatory Measurements on Notice of Construction Sources

This section identifies NOCs active in 2009 that were potential sources of radionuclide emissions. As part of the approval process for these NOCs, potential maximum emission levels were calculated based on descriptions of work proposed at the sources. The calculated levels would cause negligible dose impacts, and the sources are not usually amenable to conventional gaseous-extraction, or record sampling. As a consequence, WDOH has approved a variety of alternative measurement methods, defined below, by which to periodically confirm that NOC sources generate only low emissions of radionuclides.

Information on active NOCs and their corresponding methods of periodic confirmatory measurements (PCMs) are summarized in Table 5-5. The NOCs listed are consistent with the database maintained for the Hanford Site Air Operating Permit; PCM details are kept on file.

In the far right-hand column of Table 5-5, "Y" stands for "yes," "N" for "no," and "NA" for "not applicable" (which also means that no activities were conducted under the respective NOC). All "Y" entries are qualified by a superscripted numeral. The superscripted numerals correspond to the PCM verification methods used, which are:

- 1A — Stack monitoring; see Table 2-1 for the stack cited*
- 1B — Stack monitoring; see Table 2-2 for the stack cited*
- 2 — Dose-rate surveys and/or surface smears
- 3 — Continuous air monitor (CAM) data
- 4 — Ambient air monitoring near sources
- 5 — Nondestructive analysis (NDA) of HEPA filters; see Table 5-3, if applicable
- 6 — Based on methods and/or factors in WAC 246-247-030(21)(a) or 40 CFR 61 Appendix D or on an alternate method approved by WDOH in, for example, an NOC
- 7 — Destructive analysis of HEPA filters.

*Using this PCM method, airborne radionuclides originating from an NOC source are by design drawn into a stack ventilation system and sampled as part of the cumulative emission exhausted via that stack.

In some cases, the PCM verification method cited in Table 5-5 is followed by a parenthetical reference to a stack or to another table within this report, which presents the respective PCM verification information or data.

Table 5-5. Periodic Confirmatory Measurements on Notice of Construction Emission Sources in 2009.
(7 sheets)

Location (AOP Emission Point)	Project	Permit ID	Issue Date	Low emissions verified? (Y, N, or NA) ^a
BNI				
Waste Treatment and Immobilization Plant (200 Area Diffuse/Fugitive, Guzzler)	Excavation Activities for the Building of Temporary Construction Facilities and Main Facilities (WDOH NOC ID 672)	AIR 06-1032 (obsoleted 6/18/09)	10/5/06	Y ²
Waste Treatment and Immobilization Plant (HV-C2, HV-S1, HV-S2, HV-S3A, HV-S3B, HV-S4, IHLW-S1)	Construction of WTP High Level Waste Vitrification Plant Rev. 4 (WDOH NOC ID 625)	AIR 06-401	4/4/06	NA
Waste Treatment and Immobilization Plant (LB-C2, LB-S1, LB-S2)	Construction of WTP Laboratory Rev. 4 (WDOH NOC ID 626)	AIR 06-402	4/4/06	NA
Waste Treatment and Immobilization Plant (LV-C2, LV-S1, LV-S2, LV-S3)	Construction of the WTP LAW Vitrification Plant, Rev. 4A (WDOH NOC ID 627)	AIR 07-601	6/8/07	NA
Waste Treatment and Immobilization Plant (PT-C2, PT-S1, PT-S2, PT-S3, PT-S4)	Construction of WTP Pretreatment Plant Rev. 4 (WDOH NOC ID 628)	AIR 06-404	4/4/06	NA
CHPRC				
200 Area (200 Area Diffuse/Fugitive)	Characterization and Stabilization Activities on the Central Plateau (WDOH NOC ID 699)	AIR 06-1053	10/5/06	Y ² ; Y ⁴ , (Table 5-6)
200 Area (200 Area Diffuse/Fugitive, PTRAEU, HEPA Vacuums, Guzzler)	Roof Replacement Activities on the Central Plateau (WDOH NOC ID 670)	AIR 06-1030	10/5/06	Y ² ; Y ⁵ ; Y ⁴ (Table 5-6); NA (Table 5-3)
200 Area Interim Storage Area at the CSB (200 Area ISA)	Construction and Operation of the 200 Area Interim Storage Area at the CSB (WDOH NOC ID 650)	AIR 06-1015	10/5/06	Y ²
200 Area Effluent Treatment Facility (200E P-2025E ETF, 200 Area Diffuse/Fugitive)	Operation of LERF and 200 Area ETF (WDOH NOC ID 690)	AIR 06-1045	10/5/06	Y ^{1B} (296-E-1 in Table 2-2); Y ⁴ (Table 5-6)
200 Area Liquid Effluent Retention Facility (200E P-242AL42-001, 200E P-242AL43-001, 200E P-242AL44-001)				
209-E Criticality Lab (200E P-296P031-001)	Surveillance and Maintenance of the 209-E Criticality Laboratory (WDOH NOC ID 707)	AIR 08-1022	10/31/08	Y ^{1A} (296-P-31 in Table 2-1)
340-A Building (300 P-340NTEX-001)	Operation of the 340 Waste Storage Facility (WDOH NOC ID 704)	AIR 06-1058	10/5/06	Y ^{1B} (340-NT-EX)
B Plant (200E P-296B001-001)	Operation of the 296-B-1 Emission Unit (WDOH NOC ID 645)	AIR 06-1010	10/5/06	Y ^{1A} (296-B-1 in Table 2-1)

Table 5-5. Periodic Confirmatory Measurements on Notice of Construction Emission Sources in 2009.
(7 sheets)

Location (AOP Emission Point)	Project	Permit ID	Issue Date	Low emissions verified? (Y, N, or NA) ^a
Canister Storage Building (200F P-296H212-001)	Construction and Operation of the Canister Storage Building (WDOH NOC ID 652)	AIR 06-1017 (obsoleted 1/26/09)	10/5/06	Y ^{1A} (296-H-212);
	Canister Storage Building, Building 212-II (WDOH NOC ID 652)	AIR 09-106	1/26/09	Y ³ ; Y ⁴ (Table 5-6)
Central Waste Complex (200W J-CWC-001, 200W W-PORTEX 011)	Central Waste Complex (CWC) Operations (WDOH NOC ID 654)	AIR 08-801	8/5/08	Y ² ; Y ³ (W130); Y ⁴ (Table 5-6)
Cold Vacuum Drying Facility (100K P-296K142-001)	Construction and Operation of the Cold Vacuum Drying Facility (WDOH NOC ID 643)	AIR 06-1009	10/5/06	Y ^{1A} (296-K-142 in Table 2-1)
Cold Vacuum Drying Facility (100 K Diffuse Fugitive)	Waste Repackaging Outdoors at Cold Vacuum Drying Facility (WDOH NOC ID 742)	AIR 08-1019	10/31/08	Y ² ; Y ⁴ (Table 5-6)
Decontamination Trailers (200 Area Diffuse/Fugitive, 200 Decon Trailer (Intermittent Powered Exhaust), 200 Decon Trailer (Collection Tank Vents)	200/600 Areas Facilities Support Decontamination Trailer (Intermittent Power Exhaust) (WDOH NOC ID 678)	AIR 07-1102	11/15/2007	Y ² ; Y ⁴ (Table 5-6)
FFTF (400 Area Diffuse/Fugitive Emissions, 400 P-437MN&ST-001, 400 P-FFTFHTTR-001, 400 P-FFTFCBEX-001, 400 P-437-002, 400 FFTF PTRAEUs)	Sodium Residuals Removal and Other Deactivation Activities (WDOH NOC ID 646)	AIR 08-1021	10/31/08	Y ^{1B} (437-MN&ST, FFTF-CB-EX, 437-1-61 in Table 2-2); Y ² ; Y ⁴ (Table 5-8)
FFTF Sodium Storage Facility (400 Sodium Storage Facility)	Construction and Operation of the Sodium Storage Facility (WDOH NOC ID 639)	AIR 06-1007	10/5/06	Y ² ; Y ⁴ (Table 5-8)
Low Level Burial Grounds (200 Area Diffuse/Fugitive, HEPA Vacuums, 200W DVS Active 200W DVS Passive 200W Drum Venting System 2)	Operation of the Transuranic Waste Retrieval Project (WDOH NOC ID 719)	AIR 07-1012	10/22/07	Y ² ; Y ⁴ (Table 5-6); Y ⁶ (Table 5-2)
Low Level Burial Grounds (200W P-Trench31-001, 200W P-Trench34-001)	LLBG Mixed Waste Disposal, Trench 31 and 34 Leachate Collection and Storage Tank (WDOH NOC ID 662)	AIR 06-1023	10/5/06	Y ²
Low Level Burial Grounds (200 Area Diffuse Fugitive, 200 W-TRUDEFCON-001, 200 W-TRUDEFCON-002)	Decontamination Trailer of the Transuranic Waste Retrieval Project (WDOH NOC ID 743)	AIR 09-502	5/12/09	Y ⁴ (Table 5-6)

Table 5-5. Periodic Confirmatory Measurements on Notice of Construction Emission Sources in 2009.
(7 sheets)

Location (AOP Emission Point)	Project	Permit ID	Issue Date	Low emissions verified? (Y, N, or NA)^a
Plutonium Finishing Plant (200 Area Diffuse/Fugitive, Concrete Containers, 200W P-291Z001-001, 200W P-296Z005-001, 200W P-296Z006-001, 200W P-296Z007-001)	Transition of the Plutonium Finishing Plant Complex (WDOH NOC ID 655)	AIR 06-1020	10/5/06	Y ² ; Y ³ ; Y ⁴ (Table 5-6); Y ^{1A} (291-Z-1, 296-Z-7 in Table 2-1); Y ^{1B} (296-Z-5, 296-Z-6 in Table 2-2)
PUREX Storage Tunnels (200E P-296A010-001)	Reactivation of PUREX Storage Tunnel Number 2 (WDOH NOC ID 665)	AIR 06-1026	10/5/06	NA (296-A-10 in Table 2-2)
Purgewater Storage and Treatment Facility (200 J-NONPOINT 012)	Purgewater Storage and Treatment Facility, Purgewater Modutanks (WDOH NOC ID 636)	AIR 06-1004 (obsoleted 8/11/09)	10/5/06	Y ⁴ (Table 5-6)
	Demolition of the Purgewater Storage and Treatment Facility Unit #1 (WDOH NOC ID 747)	AIR 09-804	8/11/09	Y ² ; Y ⁴ (Table 5-6)
T Plant Complex (200W P-291T001-001, 200 Area Diffuse/Fugitive, PTRAEU)	Consolidated T Plant Operations (WDOH NOC ID 711)	AIR 07-306	3/23/07	Y ^{1A} (291-T-1 in Table 2-1); Y ² ; Y ⁵ ; Y ⁴ (Table 5-6)
T Plant Complex (200W P-296T007-001, 200 Area Diffuse/Fugitive)	Operation of the 2706-T Building (WDOH NOC ID 648)	AIR 06-1013	10/5/06	Y ^{1B} (296-T-7 in Table 2-2); Y ⁴ (Table 5-6)
Integrated Disposal Facility (200 Area Diffuse/Fugitive)	Operation of the Integrated Disposal Facility (WDOH NOC ID 713)	AIR 06-1063	10/5/06	Y ⁴ (Table 5-6)
Waste Encapsulation and Storage Facility (200E P-296B010-001)	WESF Liquid Low Level Radioactive Liquid Removal from Tank 100 (WDOH NOC ID 649)	AIR 06-1014	10/5/06	Y ^{1A} (296-B-10 in Table 2-1)
Waste Receiving and Processing Facility (200W P-296W004 001, 200 Area Diffuse/Fugitive)	Construction and Operation of the Waste Receiving and Processing Facility (WDOH NOC ID 638)	AIR 08-802	8/5/08	Y ^{1A} (296-W-4 in Table 2-1); Y ⁴ (Table 5-6)
WRAP Head Space Gas Sampling (HSGS) Facility (200W S-MO444-001)	WRAP Head Space Gas Sampling (HSGS) Analysis (WDOH NOC ID 656)	AIR 07-304	3/23/2007	Y ⁶
MSA/FH				
200 Area (200 Area Diffuse/Fugitive)	Cleaning Radiologically Contaminated Vehicles (WDOH NOC ID 715)	AIR 06-1065	10/5/06	Y ² ; Y ⁴ (Table 5-6)
HAMMER (600 J-HAMMER-001)	Use of Radioactive Materials at the Volpentest HAMMER/Hanford Training and Education Center (WDOH NOC ID 749)	AIR 09-903	9/15/09	Y ²

Table 5-5. Periodic Confirmatory Measurements on Notice of Construction Emission Sources in 2009.
(7 sheets)

Location (AOP Emission Point)	Project	Permit ID	Issue Date	Low emissions verified? (Y, N, or NA)^a
Waste Sampling and Characterization Facility (600 S-6266-001, 600 S-6266-002, 600 J NONPOINT Source)	Use of Portable Tanks and Revised Source Term at WSCF (WDOH NOC ID 669)	AIR 06-1029	10/5/06	Y ^{1B} (696-W-1 and 696-W-2 in Table 2-2); Y ² ; Y ⁴ (Table 5-6)
PNNL				
318 Building (300 EP-318-01-S)	Calibration and Development Activities in the Radiological Calibrations Laboratory (318 Building) (WDOH NOC ID 681)	AIR 06-1037	10/5/06	Y ^{1B} (EP-318-01-S in Table 2-2)
325 Building (300 EP-325-01-S)	Radiological Processing Laboratory (325 Building) (WDOH NOC ID 687)	AIR 06-1042	10/5/06	Y ^{1A} ; Y ⁶ (EP-325-01-S in Table 2-1)
326 Building (300 EP-326-01-S)	Research Activities in the Material Sciences Laboratory (326 Building) (WDOH NOC ID 677)	AIR 06-1036	10/5/06	Y ^{1B} (EP-326-01-S in Table 2-2)
329 Building (300 EP-329-01-S)	Research Activities in the Chemical Sciences Laboratory (329 Building) (WDOH NOC ID 701)	AIR 06-1055	10/5/06	Y ^{1B} (EP-329-01-S in Table 2-2)
331 Building (300 EP-331-01-V)	Research Activities in the Life Sciences Laboratory - 1 (331 Building) (WDOH NOC ID 712)	AIR 08-607	6/26/08	Y ^{1A} ; Y ⁶ (EP-331-01-V in Table 2-1)
361 Building (300 J-361-001)	Operation of the 361 Building in Testing Equipment Operability Utilizing Radioxenon (WDOH NOC ID 657)	AIR 08-403	4/30/08	Y ⁶
WCH				
300 Area (300 Area Diffuse Fugitive)	300 Area Excavation Activities (WDOH NOC ID 684) [NOC not in use]	AIR 08-1020	10/31/08	Y ⁴ (Table 5-6)
WRPS				
222-S Laboratory (200W S-296S021-001)	Hot Cell Expansion (WDOH NOC ID 637) License to Operate the 222-S Laboratory (WDOH NOC ID 716)	AIR 08-904	9/8/08	Y ^{1A} (296-S-21 in Table 2-1)
242-A Evaporator (200I: P-242A-002)	Operation of the 242-A Evaporator (WDOH NOC ID 651)	AIR 06-1016	10/5/06	Y ^{1B} (296-A-22 in Table 2-2)
241-AN Tank Farm (200 Area Diffuse Fugitive)	241-AN Tank Farm Installation and Operation of a New Ventilation System (WDOH NOC ID 692)	AIR 06-1046	10/5/06	Y ² ; Y ⁴ (Table 5-6)
241-AN Tank Farm (200I: P-296AN-001)	Installation and Operation of a Waste Retrieval System in Tanks 241-AN-101, -102, -103, -104, -105, -106, -107 (WDOH NOC ID 668)	AIR 06-1028	10/5/06	NA

Table 5-5. Periodic Confirmatory Measurements on Notice of Construction Emission Sources in 2009.
(7 sheets)

Location (AOP Emission Point)	Project	Permit ID	Issue Date	Low emissions verified? (Y, N, or NA) ^a
241-AN & 241-AW Tank Farms (200E P-296A044-001, 200E P-296A045-001, 200E P-296A046-001, 200E P-296A047-001)	Operation of New Ventilation Systems in the AN and AW Tank Farms (WDOH NOC ID 706)	AIR 06-1060	10/5/06	Y ^{1A}
241-AW Tank Farm (200 Area Diffuse/Fugitive)	Installation and Operation of a New Ventilation System (WDOH NOC ID 693)	AIR 06-1047	10/5/06	Y ² ; Y ⁴ (Table 5-6)
241-AP Tank Farm (200E P-296AP-001)	Installation and Operation of Waste Retrieval System in Tanks 241-AP-102 and 241-AP-104 (WDOH NOC ID 666)	AIR 06-1027	10/5/06	Y ^{1B} (296-A-40 in Table 2-2)
241-AY/AZ Tank Farm (200E P-296A042-001 PTRAI:U, HEPA Vacuums, Guzzler, 200 Area Diffuse/Fugitive)	License to Operate Ventilation of the 241 AY/AZ Tank Farm (WDOH NOC ID 708)	AIR 08-908	9/8/08	Y ^{1A} (296-A-42 in Table 2-1); Y ⁴ (Table 5-6)
241-AZ Tank Farm (200E P-296A020-001)	241-AZ Tank Farm Annulus Exhauster Operation (WDOH NOC ID 671)	AIR 06-1031	10/5/06	Y ^{1B} (296-A-20 in Table 2-2)
241-C Tank Farm (200 Area Diffuse/Fugitive, 200 W-296P048-001)	241-C-200 Series Tanks Retrieval (WDOH NOC ID 698) [Did not operate under this NOC in 2009.]	AIR 06-1052	10/5/06	NA (200 Area diffuse/fugitive covered under AIR 09-704)
241-C-106 Tank (200 Area Diffuse/Fugitive, 200E W-296P047-001)	Liquid Pumping and Enhanced Sluicing Rev. 6 (WDOH NOC ID 683) [Did not operate under this NOC in 2009.]	AIR 06-1038	10/5/06	NA (200 Area diffuse/fugitive covered under AIR 09-704)
241-ER-311 Catch Tank (200 Area Diffuse/Fugitive, 200 W-296P045-001, 200E P-241ER311-001)	Removal of Liquid from Catch Tank 241-ER-311 (WDOH NOC ID 718) [Did not operate in 2009.]	AIR 08-1106	11/10/08	Y ⁴ (Table 5-6)
241-S Tank Farm (200 W-296P043-001, 200 W-296P044-001, 200W P-241S102-001, 200 Area Diffuse/Fugitive)	Installation and Operation of a Waste Retrieval System in Tank 241-S-102 (WDOH NOC ID 694)	AIR 08-1105 (obsoleted 7/31/09)	11/10/08	Y ^{1A} (296-P-44 in Table 2-1); Y ² ;
		AIR 09-708	7/31/09	Y ⁴ (Table 5-6)
241-S-112 Tank (200 W-296P-043-001, 200W P-241S-001 (241-S-112), 200 Area Diffuse/Fugitive)	Installation and Operation of Waste Retrieval Systems in Single-Shell Tank (SST) 241-S-112 (WDOH NOC ID 686) [Did not operate in 2009.]	AIR 08-1103	11/10/08	Y ² ; Y ⁴ (Table 5-6)
241-UX/U/AZ/S Tank Farms (200W P-241UX302A-001, 200W P-241U301B-001, 200E P-241AZ154-001, 200W P-241S302-001)	Installation and Operation of Breather Filters on Miscellaneous Tanks (WDOH NOC ID 739)	AIR 08-1014	10/14/08	Y ²

Table 5-5. Periodic Confirmatory Measurements on Notice of Construction Emission Sources in 2009.
(7 sheets)

Location (AOP Emission Point)	Project	Permit ID	Issue Date	Low emissions verified? (Y, N, or NA) ^a
244 DCRTs Isolation and Closure (200 Area Diffuse/Fugitive, 200E P-244A-002, 200E P-244BX-002, 200W P-244S-002, 200W P-244TX-002, 200E P-244A-003, 200E P-244BX-003, 200W P-244S-003, P-244TX-003)	Isolation and Closure of Stacks 296-A-25, 296-B-28, 296-S-22, and 296-T-18 (WDOH NOC ID 697)	AIR 08-1107	11/10/08	Y ² ; Y ⁴ (Table 5-6)
244-CR DCRT (200 Area Diffuse/Fugitive, 200E P-244CR-002, 200E P-244CR-003, 200E W-296P47-001, Guzzler.)	244-CR Vault Isolation and Interim Stabilization (WDOH NOC ID 685)	AIR 08-1111 (obsoleted 9/15/09)	11/13/08	Y ² ; Y ⁴ (Table 5-6);
		AIR 09-902	9/15/09	Y ⁵ (Table 5-3)
Tank Farms (200 Area Diffuse/Fugitive)	Tank Farms Decontamination Trailer (WDOH NOC ID 695)	AIR 06-1049	10/5/06	Y ² ; Y ⁴ (Table 5-6)
	Vapor Sampling of Miscellaneous Underground Units with No Known Path of Ventilation (WDOH NOC ID 674)	AIR 06-1034	10/5/06	
Tank Farms (200 Area Diffuse/Fugitive, PTRAEU)	Categorical Tank Farm Facility Entry and Surveillance (WDOH NOC ID 673)	AIR 06-1033	10/5/06	Y ² ; Y ⁴ (Table 5-6); Y ⁶ (Table 5-1)
		AIR 06-1059	10/5/06	NA (NOC not used)
Tank Farms, Bulk Vit Demo (200 Area Diffuse/Fugitive, 200W P-BULKVIT-001)	Supplemental Treatment Test and Demonstration Facility (WDOH NOC ID 705)	AIR 06-1059	10/5/06	NA (NOC not used)
Tank Farms, Guzzler (Guzzler at Tank Farms)	Guzzler Excavation and Backfilling Activities in Support of the 200 East Area A Farm Complex (WDOH NOC ID 647)	AIR 06-1012	10/5/06	NA (NOC not used)
Tank Farms, Project E-525 (200 Area Diffuse/Fugitive, 200E P-241AZ301-001)	Double Shell Tanks Transfer System Modifications (WDOH NOC ID 688)	AIR 08-1104	11/10/08	Y ² ; Y ⁴ (Table 5-6)
Tank Farms, Project W-314 (200 Area Diffuse/Fugitive, PTRAEU, Guzzler)	Tank Farms Restoration and Safe Operations (Project W-314) (WDOH NOC ID 689)	AIR 06-1044	10/5/06	NA (NOC not used)
		AIR 06-1056 (obsoleted 7/28/09)	10/5/06	Y ² ; Y ⁴ (Table 5-6)
Tank Farms, Retrieval Project (200 Area Diffuse/Fugitive, Guzzler)	Categorical Tank Farm Facility Waste Retrieval and Closure Phase I, Site Preparation and System Installation (WDOH NOC ID 702)	AIR 09-706	7/28/09	Y ⁵ (Table 5-3)

Table 5-5. Periodic Confirmatory Measurements on Notice of Construction Emission Sources in 2009.
(7 sheets)

Location (AOP Emission Point)	Project	Permit ID	Issue Date	Low emissions verified? (Y, N, or NA) ^a
Tank Farms, Retrieval Project (200 W-296P045-001, 200 W-296P043-001, 200 W-296P044-001, 200 Area Diffuse/Fugitive, 200 W-296P047-001, 200W-296P048-001, 200 W-296P049-001, 200 W-296P050-001)	Categorical Tank Farm Facility Waste Retrieval and Closure: Phase II, Waste Retrieval Operations (WDOH NOC ID 703)	AIR 07-305 (obsoleted 7/28/09)	3/23/07	Y ^{1A} (296-P-48 in Table 2-1); Y ² ; Y ⁵ ; Y ⁴ (Table 5-6)
		AIR 09-704	7/28/09	
Tank Farms, Vadose Zone (200 Area Diffuse/Fugitive, 200 P-Vadose-002, 200 P-Vadose-003)	Vadose Zone Characterization (WDOH NOC ID 635)	AIR 06-1003	10/5/06	Y ⁵ ; Y ⁷ (Vadose-002) Y ² ; Y ⁴ (Table 5-6)
Site-wide				
Site-wide HEPA Vacuums (200 W-PORTEX 007)	HEPA Filtered Vacuum Radioactive Air Emission Units (WDOH NOC ID 663)	AIR 06-1024	10/5/06	Y ² ; Y ⁵ ; Y ⁶ (Table 5-2)
Site-wide Guzzler (Sitewide Guzzler)	Categorical Guzzler Vacuum Excavation System for Radiologically Limited Activities on the Hanford Site (WDOH NOC ID 658)	AIR 08-404	4/30/08	Y ² Y ⁵ (Table 5-3)
Site-wide PTRAEU (PTRAEU)	Portable/Temporary Radionuclide Airborne Emissions Units (WDOH NOC ID 664)	AIR 06-1025	10/5/06	Y ² , Y ³ , Y ⁵ ; Y ⁶ (Table 5-1)
Site-wide Tanker Truck (Tanker Truck Transfers)	Tanker Truck Loading of Radioactive Contaminated Waste Water (WDOH NOC ID 696)	AIR 06-1050 (obsoleted 7/28/09)	10/5/06	Y ²
		AIR 09-705	7/28/09	
Site-wide Vented Containers (Vented Containers)	Sitewide Vented Container Storage (WDOH NOC ID 641)	AIR 07-701	7/2/07	Y ⁴ (Table 5-6)

Y = yes; N = no; NA = not applicable; LAW = low-activity waste; PTRAEU = portable temporary radioactive air emission unit

^a The effective date of a revised NOC may be earlier than the issue date, which is the date WDOH issued the approval letter for the revised NOC. The effective date of a revised NOC is also the date the preceding version was obsoleted.

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5.4 AMBIENT AIR SAMPLING MEASUREMENTS

The near-facility monitoring (NFM) program comprises a comprehensive network of monitoring locations near facilities and projects at the Hanford Site. The program monitors soil, vegetation, and ambient air that may contain radionuclides dispersed there by onsite activities. It also uses thermoluminescent dosimeters to measure ambient dose rates. Emissions from many NOC activities are not measured directly at the source, as are emissions from forcibly ventilated stacks. Frequently, NOC activities are temporary and not conducted within the confines of structures having ventilation systems equipped with sampling or monitoring equipment. Hence, assessing emissions from these activities is not nearly as straightforward as is measuring stack emissions.

WDOH requires that emissions from NOC activities be measured periodically to confirm whether or not they are low. A variety of measurement data are used in this confirmation process, including those from the NFM program, dose-rate surveys, surface smears, CAM sampling, and both NDA and destructive analysis, especially of HEPA filters. Further confirmation methods are allowed, provided they are first approved by WDOH.

Summarized in Table 5-6 are the analytical data measured from ambient air samples collected during 2009, organized by general emission unit, which for regulatory purposes is construed as equivalent to an operational area such as the 100, 200, 300, 400, or 600 Area. Radionuclides with concentrations that fell below analytical detection limits in both the first and second half of the semi-annual composite samples or the quarterly composite samples were not listed in the table.

Several River Corridor Projects have requirements for annually reporting ambient air monitoring data obtained from samples collected at PNNL air monitoring stations. The PNNL stations (and their electronic data processing [EDP] codes) in proximity to these projects are as follows: "Yakima Barricade" (N907) is used for the 100-D, 100-H, and 118-K-1 Field Remediation Projects; "E100K - 118-K-1 Project" (N917) is used for the 118-K-1 Field Remediation Project; "100-H Area" (N923) is used for the 100-H Field Remediation Project; and "300 Trench" (N904), "300 NE" (N902), "300 Area South Gate"/"300 Area Composite" (N903), "300 South West" (N918), and "300 Water Intake" (N905) are used for the 300-FF-2 Field Remediation Project and the 300 Area Demolition Project. Air monitoring data related to these locations are in Table 5-7. The PNNL ambient air monitors in the 300 Area also measure emissions from the 300 Area general emission unit.

The following definitions apply to abbreviations and units of measure used in Tables 5-6 through 5-7:

- EDP = Electronic Data Processing [code] (these alpha-numeric codes, such as "N464," serve as sampler location identifiers)
- "1st half," "2nd," "1st quarter," and so on refer to standard fractional periods of the calendar year
- 1 Ci = 1 curie = 3.7 E+10 becquerels (Bq)
- pCi = picocurie = E-12 Ci
- m³ = cubic meter pCi/m³ = picocuries per cubic meter (pCi = E-12 curies)
- NA = not applicable (because up to 26 samples were analyzed each half year and up to 13 a quarter, but this table shows only a single isotopic result obtained for that period)
- ND = not detected (i.e., result less than zero, less than its overall analytical error, or no peak detected)

Table 5-6. Hanford Site Near-Facility Monitoring Air Sampling Results for 2009 (17 sheets).

100 Area

100-D Field Remediation Project					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m³			
		1st half	2nd half	Average	Maximum
N467	gross α	NA	NA	1.1 E-03	1.9 E-03
	gross β	NA	NA	1.8 E-02	4.2 E-02
	²³⁴ U	ND	1.2 E-05	1.2 E-05	1.2 E-05
	²³⁸ U	ND	1.2 E-05	1.2 E-05	1.2 E-05
	²⁴¹ Am	8.0 E-06	7.8 E-06	7.9 E-06	8.0 E-06
N468	gross α	NA	NA	1.3 E-03	2.5 E-03
	gross β	NA	NA	1.7 E-02	4.0 E-02
	²³⁴ U	4.8 E-06	7.1 E-06	6.0 E-06	7.1 E-06
	²³⁸ U	7.2 E-06	1.0 E-05	8.6 E-06	1.0 E-05
	²⁴¹ Am	1.4 E-05	6.6 E-06	1.0 E-05	1.4 E-05
N514	gross α	NA	NA	1.2 E-03	2.6 E-03
	gross β	NA	NA	1.8 E-02	4.7 E-02
	²³⁴ U	1.1 E-05	1.0 E-05	1.1 E-05	1.1 E-05
	²³⁸ U	1.2 E-05	1.4 E-05	1.3 E-05	1.4 E-05
	²⁴¹ Am	7.4 E-06	1.0 E-05	8.7 E-06	1.0 E-05
N515	gross α	NA	NA	1.3 E-03	2.6 E-03
	gross β	NA	NA	1.8 E-02	4.8 E-02
	²³⁴ U	7.3 E-06	6.7 E-06	7.0 E-06	7.3 E-06
	²³⁵ U	5.1 E-06	ND	5.1 E-06	5.1 E-06
	²³⁸ U	1.0 E-05	1.3 E-05	1.1 E-05	1.3 E-05
	^{239,240} Pu	ND	5.9 E-06	5.9 E-06	5.9 E-06
	²⁴¹ Am	1.4 E-05	5.4 E-06	9.7 E-06	1.4 E-05

100-H Field Remediation Project					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N508	gross α	NA	NA	1.3 E-03	2.5 E-03
	gross β	NA	NA	2.0 E-02	5.3 E-02
	²³⁴ U	ND	9.2 E-06	9.2 E-06	9.2 E-06
	²³⁸ U	5.9 E-06	1.1 E-05	8.7 E-06	1.1 E-05
	²⁴¹ Am	ND	1.2 E-05	1.2 E-05	1.2 E-05
N509	gross α	NA	NA	1.3 E-03	2.4 E-03
	gross β	NA	NA	1.9 E-02	4.5 E-02
	²³⁴ U	7.5 E-06	1.0 E-05	8.9 E-06	1.0 E-05
	²³⁸ U	8.2 E-06	1.2 E-05	1.0 E-05	1.2 E-05
	²⁴¹ Am	ND	1.4 E-05	1.4 E-05	1.4 E-05
N510	gross α	NA	NA	1.2 E-03	2.2 E-03
	gross β	NA	NA	1.9 E-02	4.2 E-02
	²³⁴ U	9.6 E-06	1.2 E-05	1.1 E-05	1.2 E-05
	²³⁸ U	1.1 E-05	9.1 E-06	1.0 E-05	1.1 E-05
	^{239,240} Pu	ND	5.8 E-06	5.8 E-06	5.8 E-06
N574	gross α	NA	NA	1.2 E-03	2.6 E-03
	gross β	NA	NA	1.9 E-02	4.6 E-02
	²³⁴ U	8.9 E-06	1.0 E-05	9.5 E-06	1.0 E-05
	²³⁸ U	7.5 E-06	ND	7.5 E-06	7.5 E-06
	^{239,240} Pu	ND	3.0 E-06	3.0 E-06	3.0 E-06

100-K Basins Closure Project (3 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N401	gross α	NA	NA	2.3 E-03	1.4 E-02
	gross β	NA	NA	6.3 E-02	3.1 E-01
	⁹⁰ Sr	1.9 E-03	9.0 E-03	5.5 E-03	9.0 E-03
	¹⁰⁶ Ru	1.9 E-03	ND	1.9 E-03	1.9 E-03
	¹³⁷ Cs	3.3 E-02	3.8 E-02	3.5 E-02	3.8 E-02
	²³⁴ U	ND	1.0 E-05	1.0 E-05	1.0 E-05
	²³⁸ U	8.4 E-06	9.0 E-06	8.7 E-06	9.0 E-06
	²³⁸ Pu	ND	1.5 E-04	1.5 E-04	1.5 E-04
	^{239,240} Pu	1.1 E-04	9.6 E-04	5.3 E-04	9.6 E-04
	²⁴¹ Pu	ND	7.2 E-03	7.2 E-03	7.2 E-03
	²⁴¹ Am	8.2 E-05	8.1 E-04	4.5 E-04	8.1 E-04

100-K Basins Closure Project (3 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N402	gross α	NA	NA	2.7 E -03	2.0 E -02
	gross β	NA	NA	1.3 E -01	1.2 E +00
	⁶⁰ Co	1.2 E -04	ND	1.2 E -04	1.2 E -04
	⁹⁰ Sr	9.7 E -03	1.1 E -02	1.0 E -04	1.1 E -02
	¹³⁷ Cs	7.3 E -02	1.2 E -01	9.6 E -04	1.2 E -01
	²³⁴ U	1.3 E -05	9.1 E -06	1.1 E -05	1.3 E -05
	²³⁸ U	5.3 E -06	7.0 E -06	6.1 E -06	7.0 E -06
	²³⁸ Pu	4.7 E -05	1.3 E -04	8.8 E -05	1.3 E -04
	^{239,240} Pu	2.6 E -04	1.2 E -03	7.4 E -04	1.2 E -03
	²⁴¹ Pu	1.5 E -03	9.2 E -03	5.3 E -03	9.2 E -03
	²⁴¹ Am	2.0 E -04	1.1 E -03	6.5 E -04	1.1 E -03
N403	gross α	NA	NA	1.6 E -03	6.9 E -03
	gross β	NA	NA	9.4 E -02	5.3 E -01
	⁹⁰ Sr	7.0 E -03	7.7 E -03	7.4 E -03	7.7 E -03
	¹³⁷ Cs	7.5 E -02	5.8 E -02	6.7 E -02	7.5 E -02
	²³⁴ U	9.8 E -06	1.2 E -05	1.1 E -05	1.2 E -05
	²³⁸ U	7.0 E -06	1.1 E -05	9.0 E -06	1.1 E -05
	^{239,240} Pu	3.0 E -04	4.9 E -04	4.0 E -04	4.9 E -04
	²⁴¹ Pu	1.9 E -03	3.5 E -03	2.7 E -03	3.5 E -03
	²⁴¹ Am	2.6 E -04	4.7 E -04	3.6 E -04	4.7 E -04
N404	gross α	NA	NA	2.0 E -03	5.8 E -03
	gross β	NA	NA	7.3 E -02	6.5 E -01
	⁹⁰ Sr	1.5 E -03	1.5 E -02	8.1 E -03	1.5 E -02
	¹³⁷ Cs	1.6 E -02	7.2 E -02	4.4 E -02	7.2 E -02
	²³⁴ U	8.3 E -06	1.2 E -05	9.9 E -06	1.2 E -05
	²³⁸ U	4.7 E -06	1.2 E -05	8.1 E -06	1.2 E -05
	²³⁸ Pu	1.5 E -05	6.3 E -05	3.9 E -05	6.3 E -05
	^{239,240} Pu	8.2 E -05	4.3 E -04	2.6 E -04	4.3 E -04
	²⁴¹ Pu	ND	2.9 E -03	2.9 E -03	2.9 E -03
²⁴¹ Am	7.6 E -05	4.0 E -04	2.4 E -04	4.0 E -04	
N476	gross α	NA	NA	1.4 E -03	3.8 E -03
	gross β	NA	NA	2.0 E -02	4.2 E -02
	¹³⁷ Cs	5.5 E -04	1.9 E -03	1.2 E -03	1.9 E -03
	²³⁴ U	9.2 E -06	1.2 E -05	1.1 E -05	1.2 E -05
	^{239,240} Pu	1.2 E -05	2.7 E -05	1.9 E -05	2.7 E -05
	²⁴¹ Am	7.4 E -06	2.7 E -05	1.7 E -05	2.7 E -05

100-K Basins Closure Project (3 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N477	gross α	NA	NA	1.3 E-03	2.6 E-03
	gross β	NA	NA	1.9 E-02	4.2 E-02
	⁹⁰ Sr	ND	3.4 E-04	3.4 E-04	3.4 E-04
	¹³⁷ Cs	1.1 E-03	2.5 E-03	1.8 E-03	2.5 E-03
	²³⁴ U	1.2 E-05	7.7 E-06	9.7 E-06	1.2 E-05
	²³⁸ U	8.7 E-06	7.0 E-06	7.9 E-06	8.7 E-06
	^{239 240} Pu	ND	5.4 E-05	5.4 E-05	5.4 E-05
	²⁴¹ Am	1.4 E-05	3.5 E-05	2.5 E-05	3.5 E-05
N478	gross α	NA	NA	1.2 E-03	2.6 E-03
	gross β	NA	NA	2.1 E-02	5.3 E-02
	⁹⁰ Sr	ND	4.9 E-04	4.9 E-04	4.9 E-04
	¹³⁷ Cs	1.1 E-03	2.2 E-03	1.6 E-03	2.2 E-03
	²³⁴ U	7.0 E-06	1.5 E-05	1.1 E-05	1.5 E-05
	²³⁸ U	6.3 E-06	9.1 E-06	7.7 E-06	9.1 E-06
	^{239 240} Pu	ND	3.2 E-05	3.2 E-05	3.2 E-05
	²⁴¹ Am	1.5 E-05	4.1 E-05	2.8 E-05	4.1 E-05
N479	gross α	NA	NA	1.1 E-03	2.7 E-03
	gross β	NA	NA	2.1 E-02	4.5 E-02
	¹³⁷ Cs	9.3 E-04	1.9 E-03	1.4 E-03	1.9 E-03
	²³⁴ U	7.7 E-06	7.5 E-06	7.6 E-06	7.7 E-06
	^{239 240} Pu	1.0 E-05	3.3 E-05	2.2 E-05	3.3 E-05
	²⁴¹ Am	1.6 E-05	3.5 E-05	2.5 E-05	3.5 E-05

118-K-1 Field Remediation Project					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N403	gross α	NA	NA	1.6 E 03	6.9 E-03
	gross β	NA	NA	9.4 E 02	5.3 E-01
	⁹⁰ Sr	7.0 E-03	7.7 E-03	7.4 E 03	7.7 E 03
	¹³⁷ Cs	7.5 E-02	5.8 E-02	6.7 E 02	7.5 E-02
	²³⁴ U	9.8 E-06	1.2 E 05	1.1 E 05	1.2 E-05
	²³⁸ U	7.0 E-06	1.1 E-05	9.0 E 06	1.1 E-05
	^{239 240} Pu	3.0 E-04	4.9 E-04	4.0 E 04	4.9 E-04
	²⁴¹ Pu	1.9 E-03	3.5 E-03	2.7 E 03	3.5 E-03
	²⁴¹ Am	2.6 E-04	4.7 E-04	3.6 E 04	4.7 E-04
N534	gross α	NA	NA	1.6 E 03	2.4 E-03
	gross β	NA	NA	2.2 E 02	4.0 E-02
N535	gross α	NA	NA	1.0 E 03	2.0 E-03
	gross β	NA	NA	2.1 E 02	3.6 E-02
	²³⁴ U	ND	1.6 E-05	1.6 E 05	1.6 E-05

100-N D4 and Field Remediation Projects					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N102	gross α	NA	NA	1.3 E 03	3.0 E-03
	gross β	NA	NA	1.8 E 02	4.4 E-02
	²³⁴ U	ND	9.3 E-06	9.3 E 06	9.3 E-06
	²³⁸ U	7.1 E-06	8.6 E-06	7.9 E-06	8.6 E-06
	²⁴¹ Am	9.9 E-06	8.1 E-06	9.0 E 06	9.9 E-06
N103	gross α	NA	NA	1.2 E-03	2.9 E-03
	gross β	NA	NA	1.9 E 02	4.0 E-02
	¹³⁷ Cs	1.1 E-04	2.4 E-04	1.7 E 04	2.4 E-04
	²³⁴ U	ND	8.7 E-06	8.7 E 06	8.7 E-06
	²³⁸ U	1.1 E-05	1.0 E 05	1.1 E 05	1.1 E-05
	^{239 240} Pu	8.8 E-06	ND	8.8 E-06	8.8 E-06
	²⁴¹ Am	1.7 E-05	1.1 E 05	1.4 E 05	1.7 E-05
N106	gross α	NA	NA	1.5 E 03	2.6 E-03
	gross β	NA	NA	1.8 E 02	4.3 E-02
	¹³⁷ Cs	2.0 E-04	ND	2.0 E-04	2.0 E-04
	²³⁴ U	7.2 E-06	1.0 E-05	8.7 E 06	1.0 E-05
	²³⁸ U	6.6 E-06	ND	6.6 E 06	6.6 E-06
	^{239 240} Pu	ND	4.6 E-06	4.6 E 06	4.6 E-06
	²⁴¹ Am	7.7 E-06	1.0 E-05	8.9 E-06	1.0 E-05

200 Areas

200 East Area (3 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m³			
		1st half	2nd half	Average	Maximum
N019	gross α	NA	NA	1.5 E-03	2.6 E-03
	gross β	NA	NA	1.8 E-02	4.2 E-02
	¹³⁷ Cs	ND	2.3 E-03	2.3 E-03	2.3 E-03
	²³⁴ U	1.1 E-05	ND	1.1 E-05	1.1 E-05
	²³⁸ U	ND	7.3 E-06	7.3 E-06	7.3 E-06
N158	gross α	NA	NA	1.2 E-03	2.6 E-03
	gross β	NA	NA	1.8 E-02	4.6 E-02
	²³⁴ U	7.7 E-06	ND	7.7 E-06	7.7 E-06
	²³⁸ U	7.7 E-06	1.0 E-05	8.9 E-06	1.0 E-05
N498	gross α	NA	NA	1.3 E-03	2.7 E-03
	gross β	NA	NA	1.8 E-02	3.6 E-02
	²³⁴ U	ND	1.9 E-05	1.9 E-05	1.9 E-05
	²³⁸ U	ND	8.3 E-06	8.3 E-06	8.3 E-06
	^{239,240} Pu	ND	3.3 E-06	3.3 E-06	3.3 E-06
N499	gross α	NA	NA	1.6 E-03	4.3 E-03
	gross β	NA	NA	2.0 E-02	4.7 E-02
	¹³⁴ Cs	3.4 E-04	ND	3.4 E-04	3.4 E-04
	¹³⁷ Cs	ND	2.5 E-04	2.5 E-04	2.5 E-04
	²³⁴ U	9.5 E-06	1.0 E-05	9.8 E-06	1.0 E-05
	²³⁸ U	8.8 E-06	1.0 E-05	9.4 E-06	1.0 E-05
N532	gross α	NA	NA	1.2 E-03	2.7 E-03
	gross β	NA	NA	1.9 E-02	4.6 E-02
	²³⁴ U	1.2 E-05	ND	1.2 E-05	1.2 E-05
	²³⁸ U	8.4 E-06	6.3 E-06	7.4 E-06	8.4 E-06
N559	gross α	NA	NA	1.1 E-03	1.8 E-03
	gross β	NA	NA	1.8 E-02	4.2 E-02
	²³⁴ U	8.0 E-06	1.4 E-05	1.1 E-05	1.4 E-05
	²³⁸ U	8.7 E-06	1.2 E-05	1.0 E-05	1.2 E-05
N957	gross α	NA	NA	1.4 E-03	3.3 E-03
	gross β	NA	NA	1.8 E-02	3.9 E-02
	¹³⁷ U	ND	1.4 E-04	1.4 E-04	1.4 E-04
	²³⁴ U	1.1 E-05	1.0 E-05	1.1 E-05	1.1 E-05
	²³⁸ U	ND	7.8 E-06	7.8 E-06	7.8 E-06

200 East Area (3 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N967	gross α	NA	NA	1.2 E 03	1.9 E-03
	gross β	NA	NA	1.8 E 02	4.8 E-02
	²³⁴ U	1.3 E -05	ND	1.3 E -05	1.3 E-05
	²³⁸ U	6.4 E -06	ND	6.4 E 06	6.4 E-06
N968	gross α	NA	NA	1.1 E 03	2.5 E-03
	gross β	NA	NA	1.8 E 02	4.6 E-02
	²³⁴ U	1.1 E -05	1.3 E 05	1.2 E 05	1.3 E-05
	²³⁸ U	1.6 E -05	7.6 E 06	1.2 E 05	1.6 E-05
N969	gross α	NA	NA	1.3 E 03	2.6 E-03
	gross β	NA	NA	1.9 E 02	4.8 E-02
	²³⁴ U	9.0 E 06	7.5 E 06	8.3 E -06	9.0 E-06
	²³⁸ U	5.8 E-06	5.0 E-06	5.4 E 06	5.8 E-06
N970	gross α	NA	NA	1.4 E 03	2.6 E-03
	gross β	NA	NA	1.8 E 02	4.3 E-02
	²³⁴ U	1.6 E-05	7.4 E-06	1.1 E 05	1.6 E-05
	²³⁵ U	4.3 E-06	ND	4.3 E 06	4.3 E-06
	²³⁸ U	1.1 E-05	3.4 E-06	7.1 E 06	1.1 E-05
N972	gross α	NA	NA	1.1 E 03	2.3 E -03
	gross β	NA	NA	1.8 E 02	4.5 E 02
	²³⁴ U	1.2 E-05	7.3 E-06	9.5 E 06	1.2 E -05
	²³⁸ U	8.5 E-06	ND	8.5 E 06	8.5 E-06
N973	gross α	NA	NA	1.4 E 03	3.0 E -03
	gross β	NA	NA	1.9 E 02	4.3 E-02
	¹³⁷ Cs	ND	2.0 E-04	2.0 E 04	2.0 E-04
	²³⁴ U	9.6 E-06	ND	9.6 E 06	9.6 E-06
	²³⁸ U	6.2 E-06	7.0 E 06	6.6 E 06	7.0 E-06
	^{239,240} Pu	3.1 E -05	ND	3.1 E 05	3.1 E-05
N976	gross α	NA	NA	1.3 E -03	2.7 E-03
	gross β	NA	NA	1.8 E 02	4.0 E-02
	¹³⁷ Cs	2.4 E -04	ND	2.4 E 04	2.4 E-04
	²³⁴ U	1.0 E -05	1.4 E-05	1.2 E 05	1.4 E-05
	²³⁸ U	1.8 E-05	1.3 E 05	1.6 E -05	1.8 E-05
N977	gross α	NA	NA	1.2 E 03	2.7 E-03
	gross β	NA	NA	1.9 E 02	4.1 E-02
	²³⁴ U	8.4 E-06	8.6 E 06	8.5 E 06	8.6 E-06
	²³⁸ U	9.2 E-06	6.6 E-06	7.9 E 06	9.2 E -06

200 East Area (3 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N978	gross α	NA	NA	1.3 E-03	3.1 E-03
	gross β	NA	NA	1.9 E-02	4.7 E-02
	¹³⁷ Cs	2.0 E-04	ND	2.0 E-04	2.0 E-04
	²³⁴ U	9.6 E-06	1.0 E-05	9.9 E-06	1.0 E-05
	²³⁸ U	ND	8.8 E-06	8.8 E-06	8.8 E-06
N984	gross α	NA	NA	1.3 E-03	3.0 E-03
	gross β	NA	NA	2.0 E-02	4.2 E-02
	¹³⁷ Cs	4.2 E-04	2.2 E-04	3.2 E-04	4.2 E-04
	²³⁴ U	ND	8.0 E-06	8.0 E-06	8.0 E-06
	²³⁸ U	1.1 E-05	1.0 E-05	1.1 E-05	1.1 E-05
N985	gross α	NA	NA	1.3 E-03	2.7 E-03
	gross β	NA	NA	1.8 E-02	4.3 E-02
	²³⁴ U	1.1 E-05	8.4 E-06	9.6 E-06	1.1 E-05
	²³⁵ U	3.7 E-06	ND	3.7 E-06	3.7 E-06
	²³⁸ U	9.5 E-06	7.7 E-06	8.6 E-06	9.5 E-06
N999	gross α	NA	NA	1.3 E-03	3.3 E-03
	gross β	NA	NA	1.9 E-02	5.0 E-02
	²³⁴ U	1.1 E-05	1.4 E-04	1.3 E-05	1.4 E-05
	²³⁵ U	4.8 E-06	ND	4.8 E-06	4.8 E-06
	²³⁸ U	1.5 E-05	7.3 E-06	1.1 E-05	1.5 E-05

Canister Storage Building (200 East Area)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N480	gross α	NA	NA	1.3 E-03	2.4 E-03
	gross β	NA	NA	1.8 E-02	3.9 E-02
	¹³⁷ Cs	ND	1.3 E-04	1.3 E-04	1.3 E-04
	²³⁴ U	7.0 E-06	8.0 E-06	7.5 E-06	8.0 E-06
	²³⁵ U	3.8 E-06	ND	3.8 E-06	3.8 E-06
	²³⁸ U	9.8 E-06	9.8 E-06	9.8 E-06	9.8 E-06
N481	gross α	NA	NA	1.3 E-03	2.4 E-03
	gross β	NA	NA	1.9 E-02	3.8 E-02
	²³⁴ U	1.2 E-05	8.7 E-06	1.0 E-05	1.2 E-05
	²³⁸ U	7.1 E-06	6.0 E-06	6.5 E-06	7.1 E-06
	²⁴¹ Am	8.8 E-06	ND	8.8 E-06	8.8 E-06

200 West Area (4 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N155	gross α	NA	NA	1.3 E-03	2.5 E-03
	gross β	NA	NA	1.6 E-02	4.0 E-02
	²³⁴ U	2.6 E-05	ND	2.6 E-05	2.6 E-05
	²³⁸ U	8.3 E-06	8.1 E-06	8.2 E-06	8.3 E-06
	²³⁹ / ²⁴⁰ Pu	ND	6.8 E-06	6.8 E-06	6.8 E-06
N161	gross α	NA	NA	1.3 E-03	2.5 E-03
	gross β	NA	NA	1.8 E-02	4.3 E-02
	²³⁴ U	9.1 E-06	1.2 E-05	1.0 E-05	1.2 E-05
	²³⁸ U	7.3 E-06	9.2 E-06	8.3 E-06	9.2 E-06
	²³⁹ / ²⁴⁰ Pu	5.3 E-06	5.2 E-06	5.2 E-06	5.3 E-06
N165	gross α	NA	NA	1.4 E-03	2.4 E-03
	gross β	NA	NA	1.7 E-02	4.3 E-02
	²³⁴ U	ND	9.1 E-06	9.1 E-06	9.1 E-06
	²³⁵ U	5.6 E-06	ND	5.6 E-06	5.6 E-06
	²³⁸ U	9.4 E-06	8.4 E-06	8.9 E-06	9.4 E-06
	²³⁹ / ²⁴⁰ Pu	2.4 E-04	1.0 E-04	1.7 E-04	2.4 E-04
N168	gross α	NA	NA	1.2 E-03	2.3 E-03
	gross β	NA	NA	1.8 E-02	4.5 E-02
	²³⁴ U	1.7 E-05	1.3 E-05	1.5 E-05	1.7 E-05
	²³⁸ U	1.9 E-05	1.9 E-05	1.9 E-05	1.9 E-05
	²³⁹ / ²⁴⁰ Pu	ND	8.4 E-06	8.4 E-06	8.4 E-06
N200	gross α	NA	NA	1.1 E-03	2.3 E-03
	gross β	NA	NA	1.7 E-02	4.0 E-02
	²³⁴ U	2.0 E-05	1.5 E-05	1.7 E-05	2.0 E-05
	²³⁸ U	1.0 E-05	2.0 E-05	1.5 E-05	2.0 E-05
N304	gross α	NA	NA	1.3 E-03	2.2 E-03
	gross β	NA	NA	1.7 E-02	4.6 E-02
	²³⁴ U	1.5 E-05	1.5 E-05	1.5 E-05	1.5 E-05
	²³⁸ U	ND	9.1 E-06	9.1 E-06	9.1 E-06
N433	gross α	NA	NA	2.0 E-03	6.9 E-03
	gross β	NA	NA	2.0 E-02	4.0 E-02
	²³⁴ U	1.7 E-05	1.5 E-05	1.6 E-05	1.7 E-05
	²³⁵ U	4.2 E-06	ND	4.2 E-06	4.2 E-06
	²³⁸ U	9.2 E-06	1.2 E-05	1.1 E-05	1.2 E-05
	²³⁹ / ²⁴⁰ Pu	ND	1.4 E-05	1.4 E-05	1.4 E-05

200 West Area (4 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N441	gross α	NA	NA	1.5 E-03	5.2 E-03
	gross β	NA	NA	1.9 E-02	4.2 E-02
	²³⁴ U	1.3 E-05	7.1 E-06	1.0 E-05	1.3 E-05
	²³⁸ U	ND	7.9 E-06	7.9 E-06	7.9 E-06
	^{239 240} Pu	ND	5.1 E-06	5.1 E-06	5.1 E-06
N442	gross α	NA	NA	1.5 E-03	2.6 E-03
	gross β	NA	NA	1.8 E-02	3.8 E-02
	²³⁴ U	1.3 E-05	ND	1.3 E-05	1.3 E-05
	²³⁸ U	ND	9.7 E-06	9.7 E-06	9.7 E-06
N449	gross α	NA	NA	1.5 E-03	2.5 E-03
	gross β	NA	NA	1.8 E-02	4.3 E-02
	⁹⁰ Sr	ND	2.1 E-04	2.1 E-04	2.1 E-04
	²³⁴ U	1.7 E-05	9.7 E-06	1.3 E-05	1.7 E-05
	²³⁸ U	1.9 E-05	8.1 E-06	1.4 E-05	1.9 E-05
	^{239 240} Pu	1.5 E-05	ND	1.5 E-05	1.5 E-05
N456	gross α	NA	NA	1.1 E-03	3.1 E-03
	gross β	NA	NA	1.7 E-02	3.9 E-02
	²³⁴ U	1.8 E-05	9.3 E-06	1.4 E-05	1.8 E-05
	²³⁸ U	7.4 E-06	1.3 E-05	1.0 E-05	1.3 E-05
N457	gross α	NA	NA	1.2 E-03	2.1 E-03
	gross β	NA	NA	1.7 E-02	3.4 E-02
	²³⁴ U	1.3 E-05	1.2 E-05	1.3 E-05	1.3 E-05
	²³⁸ U	ND	8.8 E-06	8.8 E-06	8.8 E-06
N550	^{239 240} Pu	ND	1.0 E-05	1.0 E-05	1.0 E-05
	gross α	NA	NA	1.3 E-03	2.4 E-03
	gross β	NA	NA	1.9 E-02	5.0 E-02
	¹³⁷ Cs	1.1 E-04	ND	1.1 E-04	1.1 E-04
	²³⁴ U	2.8 E-05	2.0 E-05	2.4 E-05	2.8 E-05
N551	²³⁵ U	9.7 E-05	5.7 E-06	7.7 E-06	9.7 E-06
	²³⁸ U	1.8 E-05	1.8 E-05	1.8 E-05	1.8 E-05
	gross α	NA	NA	1.3 E-03	2.1 E-03
	gross β	NA	NA	1.9 E-02	3.8 E-02
	¹³⁷ Cs	2.2 E-04	2.6 E-04	2.4 E-04	2.6 E-04
N551	²³⁴ U	1.8 E-05	4.1 E-05	2.9 E-05	4.1 E-05
	²³⁵ U	ND	9.2 E-06	9.2 E-06	9.2 E-06
	²³⁸ U	1.9 E-05	2.7 E-05	2.3 E-05	2.7 E-05
	^{239 240} Pu	ND	1.8 E-05	1.8 E-05	1.8 E-05
	^{239 240} Pu	ND	1.8 E-05	1.8 E-05	1.8 E-05

200 West Area (4 sheets)						
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³				
		1st half	2nd half	Average	Maximum	
N554	gross α	NA	NA	1.3 E 03	2.6 E 03	
	gross β	NA	NA	1.8 E 02	4.1 E 02	
	²³⁴ U	1.3 E-05	1.3 E-05	1.3 E 05	1.3 E-05	
	²³⁵ U	6.1 E-06	ND	6.1 E 06	6.1 E-06	
	²³⁸ U	9.5 E-06	2.0 E 05	1.5 E 05	2.0 E-05	
	^{239 240} Pu	ND	3.3 E 05	3.3 E 05	3.3 E 05	
N555	gross α	NA	NA	1.2 E 03	2.4 E 03	
	gross β	NA	NA	1.9 E 02	4.0 E-02	
	²³⁴ U	1.2 E-05	ND	1.2 E 05	1.2 E-05	
	²³⁸ U	9.4 E-06	1.3 E 05	1.1 E 05	1.3 E-05	
	^{239 240} Pu	ND	8.8 E 06	8.8 E 06	8.8 E-06	
	N956	gross α	NA	NA	1.1 E 03	2.3 E-03
gross β		NA	NA	1.8 E 02	4.7 E 02	
¹³⁷ Cs		1.0 E-04	2.0 E 04	1.5 E 04	2.0 E 04	
²³⁴ U		1.0 E-05	1.3 E 05	1.2 E 05	1.3 E-05	
²³⁸ U		1.4 E-05	7.8 E-06	1.1 E 05	1.4 E-05	
N963		gross α	NA	NA	1.2 E 03	2.2 E-03
	gross β	NA	NA	1.6 E 02	3.8 E-02	
	²³⁴ U	1.4 E 05	9.4 E-06	1.2 E 05	1.4 E-05	
	²³⁸ U	5.2 E-06	8.1 E-06	6.6 E 06	8.1 E-06	
	²³⁸ Pu	ND	1.6 E-05	1.6 E 05	1.6 E-05	
	N964	gross α	NA	NA	1.2 E 03	2.3 E 03
gross β		NA	NA	1.6 E 02	3.9 E-02	
²³⁴ U		1.3 E-05	1.3 E-05	1.3 E 05	1.3 E-05	
²³⁸ U		9.0 E-06	1.2 E-05	1.1 E 05	1.2 E-05	
N965		gross α	NA	NA	1.3 E 03	2.3 E 03
		gross β	NA	NA	1.7 E 02	4.2 E 02
	²³⁴ U	1.0 E-05	8.5 E 06	9.5 E 06	1.0 E -05	
	²³⁸ U	7.0 E-06	9.8 E 06	8.4 E 06	9.8 E 06	
	N966	gross α	NA	NA	1.2 E 03	2.4 E-03
		gross β	NA	NA	1.9 E 02	4.7 E 02
²³⁴ U		1.2 E-05	7.1 E 06	9.8 E 06	1.2 E -05	
²³⁸ U		ND	5.2 E-06	5.2 E 06	5.2 E-06	
^{239 240} Pu		ND	7.5 E 06	7.5 E 06	7.5 E-06	

200 West Area (4 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N974	gross α	NA	NA	1.4 E-03	3.5 E-03
	gross β	NA	NA	1.9 E-02	4.8 E-02
	¹³⁷ Cs	ND	2.0 E-04	2.0 E-04	2.0 E-04
	²³⁴ U	9.3 E-06	1.1 E-05	1.0 E-05	1.1 E-05
	²³⁵ U	ND	4.8 E-06	4.8 E-06	4.8 E-06
	²³⁸ U	8.6 E-06	7.4 E-06	8.0 E-06	8.6 E-06
N975	gross α	NA	NA	1.4 E-03	2.5 E-03
	gross β	NA	NA	1.7 E-02	4.1 E-02
	¹³⁷ Cs	1.4 E-04	ND	1.4 E-04	1.4 E-04
	²³⁴ U	1.3 E-05	6.1 E-06	9.7 E-06	1.3 E-05
	²³⁸ U	8.6 E-06	7.4 E-06	8.0 E-06	8.6 E-06
	^{239 240} Pu	3.2 E-05	1.8 E-05	2.5 E-05	3.2 E-05
N987	gross α	NA	NA	1.4 E-03	4.4 E-03
	gross β	NA	NA	1.7 E-02	4.2 E-02
	²³⁴ U	1.2 E-05	ND	1.2 E-05	1.2 E-05
	²³⁸ U	1.2 E-05	ND	1.2 E-05	1.2 E-05
	^{239 240} Pu	2.8 E-04	9.4 E-06	1.4 E-04	2.8 E-04
N994	gross α	NA	NA	1.4 E-03	3.7 E-03
	gross β	NA	NA	1.9 E-02	4.6 E-02
	²³⁴ U	3.7 E-06	8.8 E-06	6.3 E-06	8.8 E-06
	²³⁸ U	7.5 E-06	ND	7.5 E-06	7.5 E-06

Environmental Restoration Disposal Facility (2 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N482	gross α	NA	NA	1.1 E-03	2.3 E-03
	gross β	NA	NA	1.5 E-02	3.6 E-02
	¹³⁷ Cs	ND	2.0 E-04	2.0 E-04	2.0 E-04
	²³⁴ U	2.3 E-05	3.1 E-05	2.7 E-05	3.1 E-05
	²³⁸ U	1.9 E-05	3.1 E-05	2.5 E-05	3.1 E-05
	^{239 240} Pu	7.9 E-06	1.4 E-05	1.1 E-05	1.4 E-05

Environmental Restoration Disposal Facility (2 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N517	gross α	NA	NA	1.1 E-03	2.8 E-03
	gross β	NA	NA	1.3 E-02	4.0 E-02
	¹³⁷ Cs	ND	3.8 E-04	3.8 E-04	3.8 E-04
	²³⁴ U	5.3 E-05	2.7 E-05	4.0 E-05	5.3 E-05
	²³⁵ U	3.9 E-06	ND	3.9 E-06	3.9 E-06
	²³⁸ U	3.8 E-05	2.6 E-05	3.2 E-05	3.8 E-05
	^{239 240} Pu	ND	1.5 E-05	1.5 E-05	1.5 E-05
N518	gross α	NA	NA	1.0 E-03	2.9 E-03
	gross β	NA	NA	1.6 E-02	4.4 E-02
	²³⁴ U	1.4 E-05	2.0 E-05	1.7 E-05	2.0 E-05
	²³⁸ U	1.5 E-05	2.3 E-05	1.9 E-05	2.3 E-05
N550	gross α	NA	NA	1.3 E-03	2.4 E-03
	gross β	NA	NA	1.9 E-02	5.0 E-02
	¹³⁷ Cs	1.1 E-04	ND	1.1 E-04	1.1 E-04
	²³⁴ U	2.8 E-05	2.0 E-05	2.4 E-05	2.8 E-05
	²³⁵ U	9.7 E-06	5.7 E-06	7.7 E-06	9.7 E-06
	²³⁸ U	1.8 E-05	1.8 E-05	1.8 E-05	1.8 E-05
N963	gross α	NA	NA	1.2 E-03	2.2 E-03
	gross β	NA	NA	1.6 E-02	3.8 E-02
	²³⁴ U	1.4 E-05	9.4 E-06	1.2 E-05	1.4 E-05
	²³⁸ U	5.2 E-06	8.1 E-06	6.6 E-06	8.1 E-06
	²³⁸ Pu	ND	1.6 E-05	1.6 E-05	1.6 E-05

200-North Demolition Project (2 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N563	gross α	NA	NA	9.6 E-04	1.6 E-03
	gross β	NA	NA	1.8 E-02	4.3 E-02
	²³⁴ U	1.7 E-05	2.4 E-05	2.0 E-05	2.4 E-05
	²³⁵ U	2.1 E-05	ND	2.1 E-05	2.1 E-05
	²³⁸ U	ND	1.5 E-05	1.5 E-05	1.5 E-05
	^{239 240} Pu	ND	3.8 E-06	3.8 E-06	3.8 E-06

200-North Demolition Project (2 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N564	gross α	NA	NA	1.3 E-03	2.2 E-03
	gross β	NA	NA	1.7 E-02	3.6 E-02
	²³⁴ U	2.9 E-05	5.4 E-05	4.1 E-05	5.4 E-05
	²³⁵ U	ND	6.5 E-06	6.5 E-06	6.5 E-06
	²³⁸ U	ND	8.9 E-06	8.9 E-06	8.9 E-06
	^{239,240} Pu	ND	2.8 E-06	2.8 E-06	2.8 E-06
N567	gross α	NA	NA	1.3 E-03	2.5 E-03
	gross β	NA	NA	1.9 E-02	5.2 E-02
	²³⁴ U	1.4 E-05	7.5 E-06	1.1 E-05	1.4 E-05
	^{239,240} Pu	ND	4.9 E-06	4.9 E-06	4.9 E-06
N568	gross α	NA	NA	1.4 E-03	2.3 E-03
	gross β	NA	NA	1.8 E-02	4.7 E-02
	²³⁴ U	1.9 E-05	9.4 E-06	1.4 E-05	1.9 E-05
	²³⁸ U	ND	7.3 E-06	7.3 E-06	7.3 E-06

200-UW-1 Demolition Project (200 West Area) (2 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N168	gross α	NA	NA	1.2 E-03	2.3 E-03
	gross β	NA	NA	1.8 E-02	4.5 E-02
	²³⁴ U	1.7 E-05	1.3 E-05	1.5 E-05	1.7 E-05
	²³⁸ U	1.9 E-05	1.9 E-05	1.9 E-05	1.9 E-05
	^{239,240} Pu	ND	8.4 E-06	8.4 E-06	8.4 E-06
N550	gross α	NA	NA	1.3 E-03	2.4 E-03
	gross β	NA	NA	1.9 E-02	5.0 E-02
	¹³⁷ Cs	1.1 E-04	ND	1.1 E-04	1.1 E-04
	²³⁴ U	2.8 E-05	2.0 E-05	2.4 E-05	2.8 E-05
	²³⁵ U	9.7 E-06	5.7 E-06	7.7 E-06	9.7 E-06
	²³⁸ U	1.8 E-05	1.8 E-05	1.8 E-05	1.8 E-05
N551	gross α	NA	NA	1.3 E-03	2.1 E-03
	gross β	NA	NA	1.9 E-02	3.8 E-02
	¹³⁷ U	2.2 E-04	2.6 E-04	2.4 E-04	2.6 E-04
	²³⁴ U	1.8 E-05	4.1 E-05	2.9 E-05	4.1 E-05
	²³⁵ U	ND	9.2 E-06	9.2 E-06	9.2 E-06
	²³⁸ U	1.9 E-05	2.7 E-05	2.3 E-05	2.7 E-05
	^{239,240} Pu	ND	1.8 E-05	1.8 E-05	1.8 E-05

200-UW-1 Demolition Project (200 West Area) (2 sheets)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m³			
		1st half	2nd half	Average	Maximum
N956	gross α	NA	NA	1.1 E-03	2.3 E-03
	gross β	NA	NA	1.8 E-02	4.7 E-02
	¹³⁷ Cs	1.0 E-04	2.0 E-04	1.5 E-04	2.0 E-04
	²³⁴ U	1.0 E-05	1.3 E-05	1.2 E-05	1.3 E-05
	²³⁸ U	1.4 E-05	7.8 E-06	1.1 E-05	1.4 E-05
N963	gross α	NA	NA	1.2 E-03	2.2 E-03
	gross β	NA	NA	1.6 E-02	3.8 E-02
	²³⁴ U	1.4 E-05	9.4 E-06	1.2 E-05	1.4 E-05
	²³⁸ U	5.2 E-06	8.1 E-06	6.6 E-06	8.1 E-06
	²³⁸ Pu	ND	1.6 E-05	1.6 E-05	1.6 E-05

300 Area

300-FF-2 Field Remediation Project					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m³			
		1st half	2nd half	Average	Maximum
N130	gross α	NA	NA	1.2 E-03	2.2 E-03
	gross β	NA	NA	1.9 E-02	5.0 E-02
	²³⁴ U	1.3 E-05	1.3 E-05	1.3 E-05	1.3 E-05
	²³⁵ U	6.2 E-06	ND	6.2 E-06	6.2 E-06
	²³⁸ U	5.7 E-06	9.2 E-06	7.4 E-06	9.2 E-06
N527	gross α	NA	NA	1.1 E-03	3.3 E-03
	gross β	NA	NA	2.0 E-02	4.8 E-02
	²³⁴ U	1.2 E-05	2.4 E-05	1.8 E-05	2.4 E-05
	²³⁸ U	1.0 E-05	2.4 E-05	1.7 E-05	2.4 E-05
N537	gross α	NA	NA	1.6 E-03	2.2 E-03
	gross β	NA	NA	2.9 E-02	5.4 E-02
N538	gross α	NA	NA	1.7 E-03	2.0 E-03
	gross β	NA	NA	2.6 E-02	4.3 E-02
N539	gross α	NA	NA	1.8 E-03	2.3 E-03
	gross β	NA	NA	2.8 E-02	5.4 E-02
	²³⁴ U	2.9 E-05	ND	2.9 E-05	2.9 E-05
N540	gross α	NA	NA	1.3 E-03	2.3 E-03
	gross β	NA	NA	2.6 E-02	5.0 E-02
	²³⁴ U	3.9 E-05	ND	3.9 E-05	3.9 E-05
	²³⁸ U	2.7 E-05	ND	2.7 E-05	2.7 E-05

300 Area D4 Project							
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³					
		1st quarter	2nd quarter	3rd quarter	4th quarter	Average	Maximum
N557	gross α	NA	NA	NA	NA	1.3 E-03	2.4 E-03
	gross β	NA	NA	NA	NA	1.9 E-02	4.7 E-02
	²³⁴ U	1.9 E-05	2.5 E-05	3.3 E-05	2.1 E-05	2.5 E-05	3.3 E-05
	²³⁸ U	8.1 E-06	1.3 E-05	3.3 E-05	1.3 E-05	1.7 E-05	3.3 E-05
	^{239/240} Pu	2.9 E-05	ND	ND	ND	2.9 E-05	2.9 E-05

600 Area

BC Controlled Area Decontamination & Decommissioning Project					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N572	gross α	NA	NA	1.3 E-03	2.6 E-03
	gross β	NA	NA	2.6 E-02	5.0 E-02
	²³⁴ U	ND	1.4 E-05	1.4 E-05	1.4 E-05
	²³⁸ U	ND	1.2 E-05	1.2 E-05	1.2 E-05
N573	gross α	NA	NA	1.2 E-03	2.2 E-03
	gross β	NA	NA	2.0 E-02	4.3 E-02
	²³⁸ U	ND	9.9 E-06	9.9 E-06	9.9 E-06
	^{239/240} Pu	ND	4.3 E-06	4.3 E-06	4.3 E-06
N957	gross α	NA	NA	1.4 E-03	3.3 E-03
	gross β	NA	NA	1.8 E-02	3.9 E-02
	¹³⁷ Cs	ND	1.4 E-04	1.4 E-04	1.4 E-04
	²³⁴ U	1.1 E-05	1.0 E-05	1.1 E-05	1.1 E-05
	²³⁸ U	ND	7.8 E-06	7.8 E-06	7.8 E-06
N978	gross α	NA	NA	1.3 E-03	3.1 E-03
	gross β	NA	NA	1.9 E-02	4.7 E-02
	¹³⁷ Cs	2.0 E-04	ND	2.0 E-04	2.0 E-04
	²³⁴ U	9.6 E-06	1.0 E-05	9.9 E-06	1.0 E-05
	²³⁸ U	ND	8.8 E-06	8.8 E-06	8.8 E-06

Wye Barricade (600 Area)					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m ³			
		1st half	2nd half	Average	Maximum
N981	gross α	NA	NA	1.4 E-03	2.3 E-03
	gross β	NA	NA	1.9 E-02	4.6 E-02
	²³⁴ U	1.2 E-05	7.0 E-06	9.3 E-06	1.2 E-05
	²³⁵ U	4.2 E-06	ND	4.2 E-06	4.2 E-06
	²³⁸ U	1.1 E-05	8.3 E-06	9.6 E-06	1.1 E-05

100, 200, 300, and 600 Areas

Table 5-7. Pacific Northwest National Laboratory 300 Area Air Data and Supplemental Air Data for River Corridor Closure Projects during 2009.³¹ (2 sheets)

Location (EDP code)	Radionuclide or type of radioactivity	Concentration, pCi/m ³	
		Average	Maximum
N901 (200W SE)	gross α	7.6 E-04	1.8 E-03
	gross β	1.7 E-02	4.2 E-02
	²³⁴ U	5.4 E-05	7.0 E-05
	²³⁵ U	3.5 E-06	3.5 E-06
	²³⁸ U	5.5 E-05	7.0 E-05
	²³⁸ Pu	2.7 E-06	2.7 E-06
	^{239 240} Pu	5.5 E-06	7.9 E-06
N902 (300 NE)	gross α	8.3 E-04	2.2 E-03
	gross β	1.9 E-02	4.5 E-02
	³ H	6.4 E+00	1.1 E+01
	⁴⁰ K	4.6 E-03	4.6 E-03
	²³⁴ U	5.8 E-05	7.8 E-05
	²³⁸ U	4.2 E-05	5.2 E-05
	²³⁸ Pu ^{239 240} Pu	3.7 E-06 3.4 E-06	3.7 E-06 5.0 E-06
N903 (300 South Gate and 300 Area Composite [replicate sample data included])	gross α	1.1 E-03	2.8 E-03
	gross β	2.2 E-02	5.8 E-02
	³ H	7.2 E+00	1.9 E+01
	⁴⁰ K	4.0 E-03	4.0 E-03
	²³⁴ U	4.6 E-05	5.5 E-05
	²³⁵ U	5.0 E-06	5.0 E-06
	²³⁸ U ^{239 240} Pu	5.4 E-05 1.5 E-06	6.9 E-05 1.5 E-06
N904 (300 Trench)	gross α	7.7 E-04	1.6 E-03
	gross β	1.7 E-02	4.3 E-02
	³ H	7.6 E+00	1.4 E+01

Table 5-7. Pacific Northwest National Laboratory 300 Area Air Data and Supplemental Air Data for River Corridor Closure Projects during 2009.^a (2 sheets)

Location (EDP code)	Radionuclide or type of radioactivity	Concentration, pCi/m ³	
		Average	Maximum
N905 (300 Water Intake)	gross α	8.8 E-04	2.2 E-03
	gross β	2.0 E-02	5.0 E-02
	³ H	6.8 E+00	1.4 E+01
N907 (Yakima Barricade)	gross α	9.6 E-04	1.9 E-03
	gross β	1.9 E-02	4.8 E-02
	^{239/240} Pu	3.4 E-06	4.3 E-06
N917 (E100K 118-K-1 Project)	³ H	4.2 E+00	6.3 E+00
N918 (300 South West)	gross α	9.3 E-04	2.5 E-03
	gross β	2.1 E-02	6.9 E-02
	³ H	8.6 E+00	1.6 E+01
N923 (100-H Area)	³ H	7.2 E+00	1.5 E+01

^a These data represent ambient air monitoring results for the entire year, during which WCH projects were not necessarily continuously active.

5.5 QUALITY ASSURANCE PROGRAM COMPLIANCE STATUS

Air emissions data reported in this document reflect the product of many QA activities concerned with the collecting, handling, analyzing, validating, and reporting of samples and the resultant analytical data. Those activities are identified in the quality assurance plans cited below. In addition, point-by-point comparisons of the major point source monitoring systems and laboratory methods to the quality assurance criteria of 40 CFR 61, Appendix B, Method 114, may be detailed in one or more of the QA plans or complementary documents, below. PNNL was not required to perform point-by-point comparisons because their major stacks had been upgraded to full compliance status.

EM-QA-1, *Effluent Management Quality Assurance Plan*

ENV-1-1.15, 2006, *Quality Assurance Project Plan for Radiological Air Emissions Monitoring*, Section 6.1

ETD-001, Rev. 7, 2005, *Quality Assurance Project Plan for the Hanford Site Surface Environmental Surveillance and the Drinking Water Monitoring Project*

HNF-EP-0528, *NESHAP Quality Assurance Project Plan for Radioactive Air Emissions*. [Note: In 2010, MSC-23333, below, replaced this document, which contained point-by-point comparisons of analytical methods to the requirements of Method 114 of 40 CFR 61 Appendix B. This information was moved to an appendix in Rev. 16 of HNF-EP-0835, also below, which isn't applicable to activities in 2009.]

HNF-EP-0538, *Near-Facility Environmental Monitoring Quality Assurance Project Plan*

HNF-EP-00835, *Statement of Work for Services Provided by the Waste Sampling and Characterization Facility for the Effluent and Environmental Monitoring Program during Calendar Year 2009*

HNF-SD-CP-QAPP-017, *Waste Sampling and Characterization Facility Quality Assurance Program Plan*

MSC-23333, *Environmental Quality Assurance Program Plan*, [**Note:** This document was not in force in 2009. When approved in 2010, it replaced HNF-EP-0528 and HNF-EP-0538, above.]

RPP-QAPP-004, *NESHAP Quality Assurance Program Plan for Tank Farm Contractor Radionuclide Air Emissions*

TFC-PLN-71, *NESHAP Quality Assurance Program Plan for Tank Farm Contractor Radioactive Air Emissions*.

The effluent monitoring quality assurance elements described in the above plans are compatible with one or more of the following documents:

- 10 CFR 830
- 40 CFR 61, Appendix B, "Method 114 – Test Methods for Measuring Radionuclide Emissions from Stationary Sources"
- ASME NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications, 2000 Edition*
- DOE Order 414.1C
- DOE Order 450.1A
- DOE Order 5400.5, *Radiation Protection of the Public and the Environment*
- DOE/EH-0173T
- EPA QA/R-5.

6.0 REFERENCES

- 10 CFR 830, "Nuclear Safety Management," Title 10, *Code of Federal Regulations*, Part 830, as amended.
- 40 CFR 61, *National Emission Standards for Hazardous Air Pollutants* (NESHAP), Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," Title 40, *Code of Federal Regulations*, Part 61, as amended.
- 40 CFR 70.2, "State Operating Permit Programs," Title 40, *Code of Federal Regulations*, Part 70, as amended.
- ASME NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications, 2000 Edition*, American Society of Mechanical Engineers, New York, New York.
- DOE, 1995, "Memorandum of Understanding Between the U.S. Environmental Protection Agency and the U.S. Department of Energy Concerning the Clean Air Act Emission Standards for Radionuclides 40 CFR Part 61 Including Subparts H, I, Q & T," (letter to E. Ramona, U.S. Environmental Protection Agency) from Raymond Berube, U.S. Department of Energy, Washington, D.C., May 16.
- DOE Order 414.1C, *Quality Assurance*, "Contractor Requirements Document," U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE Order 450.1A, *Environmental Protection Program*, U.S. Department of Energy, Washington, D.C.
- DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C.
- DOE/EH-0173T, 1991, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*, U.S. Department of Energy, Washington D.C.
- DOE/RL-88-30, Rev. 15, 2006, *Hanford Site Waste Management Units Report*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE/RL-91-50, Rev. 4, 2008, *Environmental Monitoring Plan, United States Department of Energy, Richland Operations Office*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. [This document was also published as PNNL-16984, with the authors listed as: Hanf, R. W., Jr., R. L. Dirkes, S. M. McKinney, T. M. Poston, K. W. Burk, J. L. Downs, D. C. Stapp, M. J. Hartman, A. Stegen, G. W. Patton, B. G. Fritz, L. E. Bisping, E. A. Lepel, and E. J. Antonio.]
- DOE/RL-96-75, Rev. 2, 1999, *Radioactive Air Emissions Notice of Construction Portable/Temporary Radioactive Air Emission Units*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE/RL-97-50, Rev. 2, 1999, *Radioactive Air Emissions Notice of Construction for HEPA Filtered Vacuum Radioactive Air Emission Units*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE/RL-2006-29, 2006, *Calculating Potential-to-Emit Radiological Releases and Doses*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- DOE/RL-2007-53, 2008, *Methods for Calculating Doses to Demonstrate Compliance with Air Pathway Radiation Dose Standards at the Hanford Site*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

- Ecology, 2006, *Hanford Site Air Operating Permit 00-05-06, Renewal 1*, Washington State Department of Ecology, Olympia, Washington.
- Ecology, 2006, *Department of Energy Hanford Site Air Emissions License #FF-01*, AIR 06-1067, Washington State Department of Ecology, Olympia, Washington.
- EM-QA-1, Rev. 7, 2010, *Effluent Management Quality Assurance Plan*, Pacific Northwest National Laboratory, Richland, Washington.
- ENV-1-1.15, 2006, *Quality Assurance Project Plan for Radiological Air Emissions Monitoring*, Washington Closure Hanford, LLC, Richland, Washington.
- EPA, 1992, *User's Guide for CAP88-PC, Version 1.0*, EPA 402-B-92-001, U.S. Environmental Protection Agency, Office of Radiation Programs, Las Vegas, Nevada.
- EPA, 2007, *CAP88-PC Version 3.0 User Guide*, U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Washington, D.C.
- EPA, 2004, *Methods for Estimating Fugitive Air Emissions of Radionuclides from Diffuse Sources at DOE Facilities*, U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Washington, D.C.
- EPA QA/R-5, 2001, *EPA Requirements for Quality Assurance Project Plans*, U.S. Environmental Protection Agency, Washington, D.C.
- EPA, 1988, *Limiting Values of Radionuclide Intake and Air Concentrations and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, EPA/520-1-88-020, Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C.
- EPA, 1993, *External Exposure to Radionuclides in Air, Water, and Soil*, Federal Guidance Report No. 12, EPA 402-R-93-081, Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, Washington, D.C. EPA QA/R-5, 2001, *EPA Requirements for Quality Assurance Project Plans*, U.S. Environmental Protection Agency, Washington, D.C.
- EPA, 1999, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides*, Federal Guidance Report No. 13, EPA 402-R-99-001, Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, Washington, D.C.
- ETD-001, Rev. 7, 2005, *Quality Assurance Project Plan for the Hanford Site Surface Environmental Surveillance and the Drinking Water Monitoring Project*, Pacific Northwest National Laboratory, Richland, Washington.
- HNF-1974-1, 2002, *Radionuclide National Emission Standards for Hazardous Air Pollutants Potential-to-Emit Assessment*, Fluor Hanford, Inc., Richland, Washington.
- HNF-EP-0835, Rev. 15, 2009, *Statement of Work for Services Provided by the Waste Sampling and Characterization Facility for the Effluent and Environmental Monitoring Program during Calendar Year 2009*, Mission Support Alliance, Richland, Washington.
- HNF-SD-CP-QAPP-017, Rev. 9, 2008, *Waste Sampling and Characterization Facility Quality Assurance Program Plan*, Fluor Hanford, Richland, Washington.
- MSC-23333, Rev. 0, 2010, *Environmental Quality Assurance Program Plan*, Mission Support Alliance, Richland, Washington.

- PNNL-6415, Rev. 18, 2007, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, Pacific Northwest National Laboratory, Richland, Washington.
- PNL-6584, 1988, *GENII – The Hanford Environmental Radiation Dosimetry Software System*, Vols. 1-3, Pacific Northwest Laboratory, Richland, Washington.
- PNL-8148, 1992, *Hanford Site Environmental Report for Calendar Year 1991*, Pacific Northwest Laboratory, Richland, Washington.
- PNNL-14428, 2004, *Hanford Area 2000 Population*, Pacific Northwest National Laboratory, Richland, Washington.
- PNNL-14583, Rev. 2c, 2008, B. A. Napier, *GENII Version 2 Users' Guide*, Pacific Northwest National Laboratory, Richland, Washington.
- PNNL-17847, Rev. 1 [aka CRL-TECH-ESH-007, Rev. 1], 2009, K. Rhoads and Barnett, J. M., *PNNL Site Dose-per-Unit-Release Factors for Use in Calculating Radionuclide Air Emissions Potential-to-Emit Doses*, Pacific Northwest National Laboratory, Richland, Washington.
- PNNL-19455, 2010, *Hanford Site Environmental Report for Calendar Year 2009*, Pacific Northwest National Laboratory, Richland, Washington. [in press]
- PNNL-19455, APP. 1, 2010. *Hanford Site Environmental Surveillance Data Report for Calendar Year 2009*, Pacific Northwest National Laboratory, Richland, Washington. [in press]
- PNNL-19455, APP. 2, 2010, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 2009*, Pacific Northwest National Laboratory, Richland, Washington. [in press]
- SAND91-0561A, 1991, *User's Guide for GENII-S: A Code for Statistical and Deterministic Simulations of Radiation Doses to Humans from Radionuclides in the Environment*. Sandia National Laboratories, Albuquerque, New Mexico.
- TFC-PLN-71, April 2008, *NESHAP Quality Assurance Program Plan for Tank Farm Contractor Radioactive Air Emissions*, CH2M HILL Hanford Group, Inc., Richland, Washington, and Washington River Protection Solutions, LLC, Richland Washington.
- WAC 246-247, "Radiation Protection – Air Emissions," *Washington Administrative Code*, Olympia, Washington.

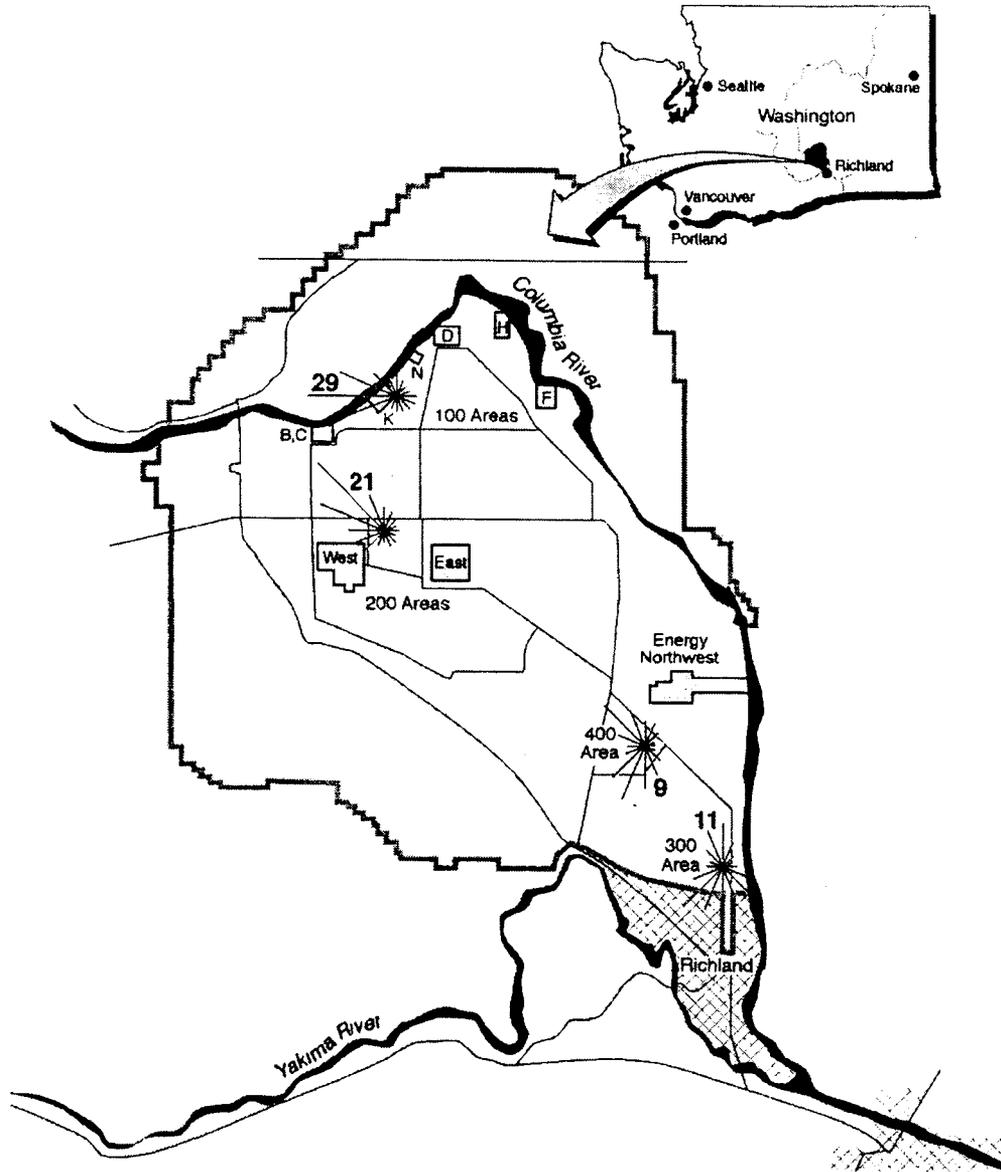
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APPENDIX A

DOSE MODELING AND METEOROLOGICAL DATA

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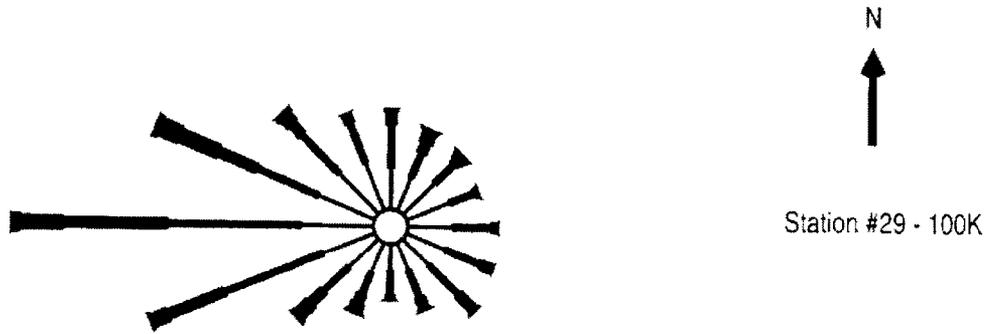
Figure A-1. Meteorological Stations in 2009.*



* Windroses at meteorological stations are symbolic. See Figures A-2 through A-5 for actual windrose maps for 2009 at those stations.)

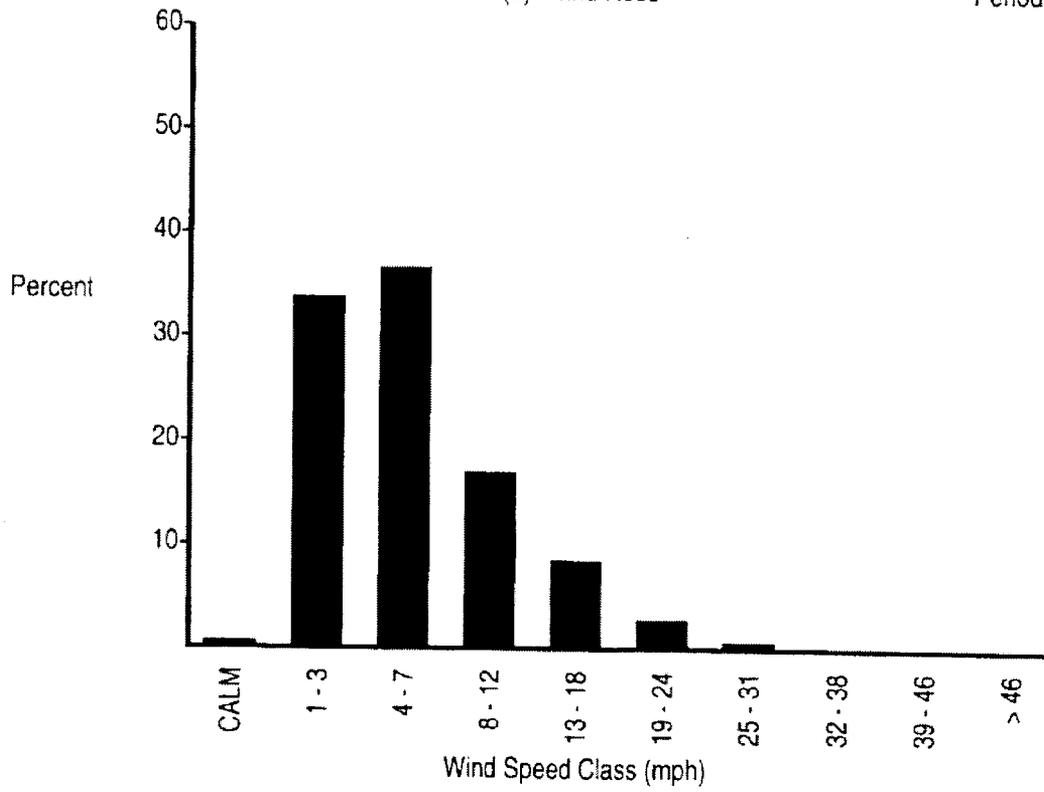
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Figure A-2. 100-K Area Wind Rose and Histogram.



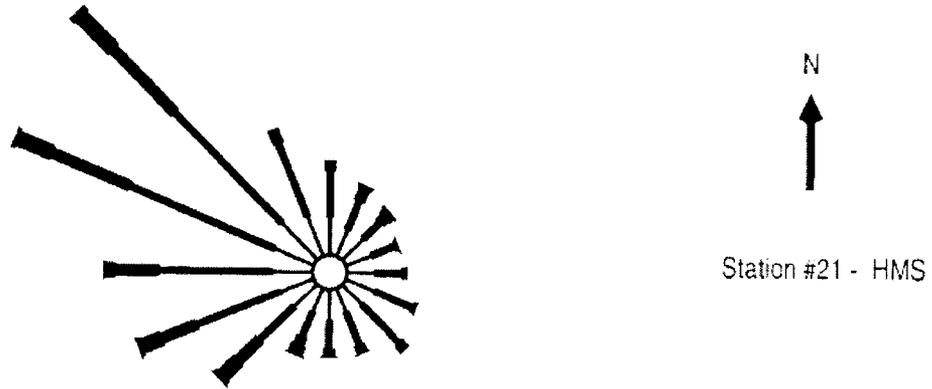
(a) Wind Rose

Period: 1/2009 - 12/2009



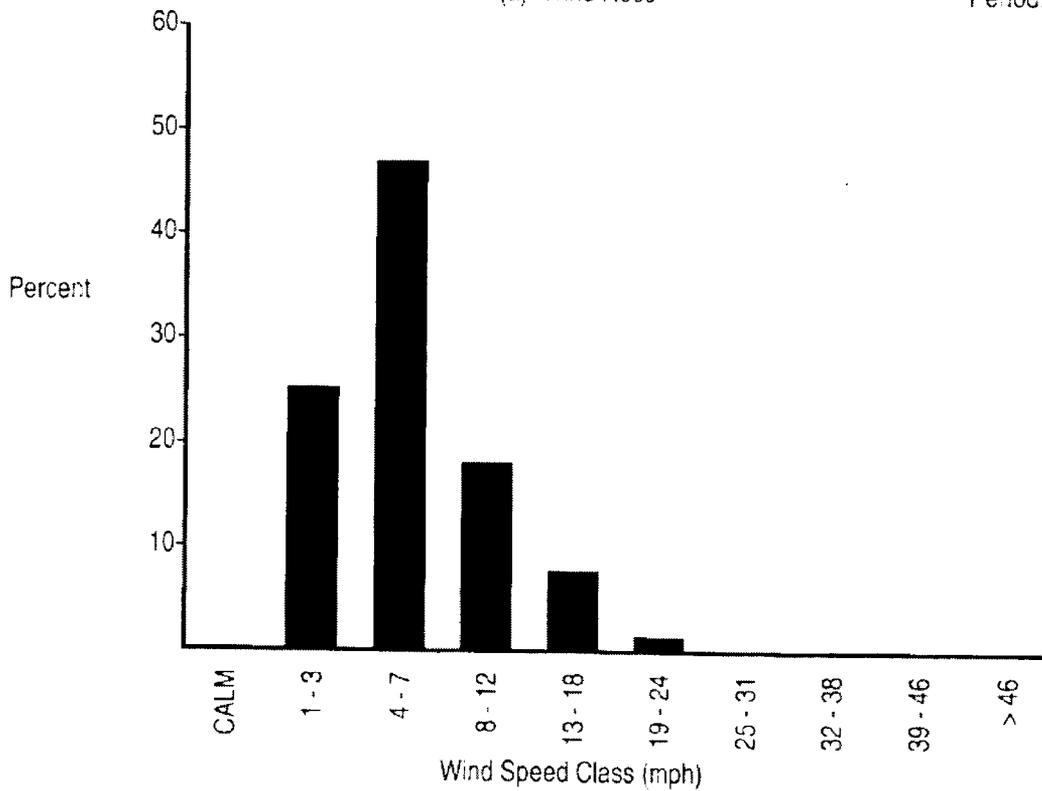
(b) Wind Speed Histogram

Figure A-3. 200 Area Wind Rose and Histogram.



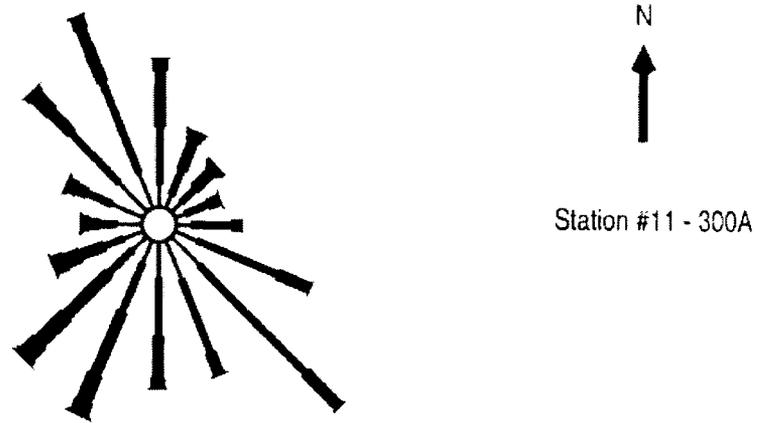
(a) Wind Rose

Period: 1/2009 - 12/2009



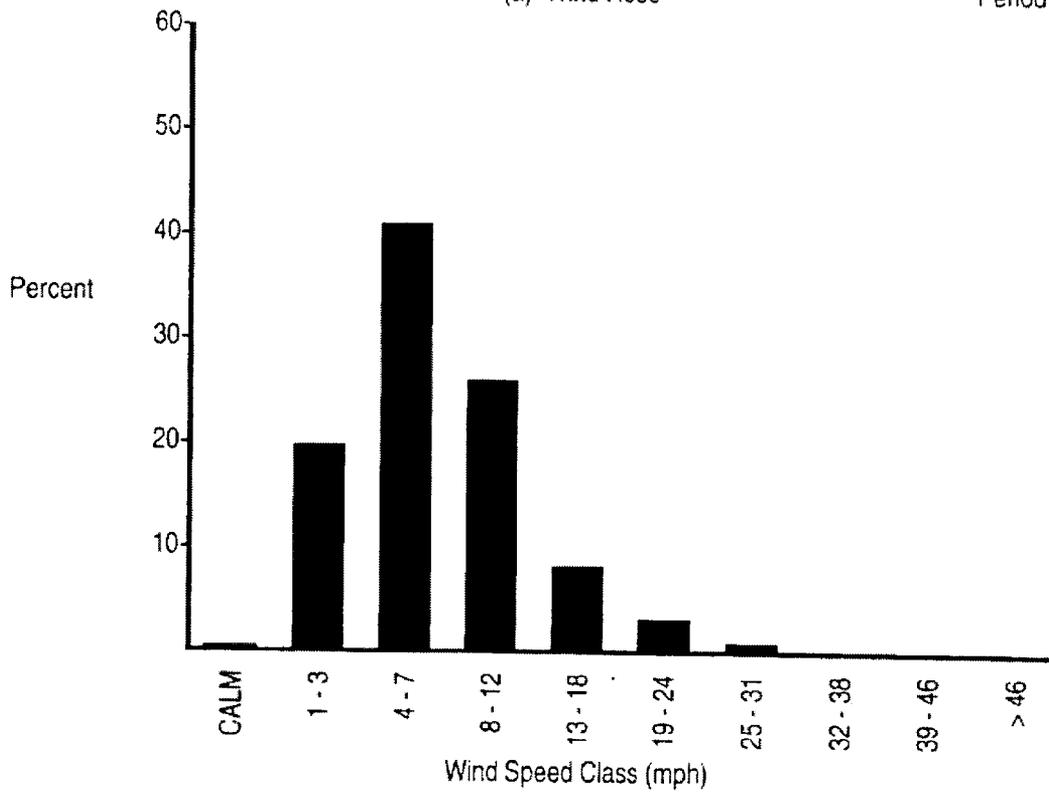
(b) Wind Speed Histogram

Figure A-4. 300 Area Wind Rose and Histogram.



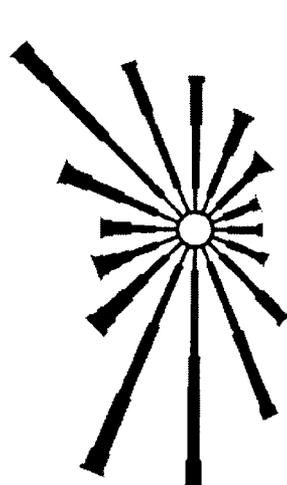
(a) Wind Rose

Period: 1/2009 - 12/2009



(b) Wind Speed Histogram

Figure A-5. 400 Area Wind Rose and Histogram.



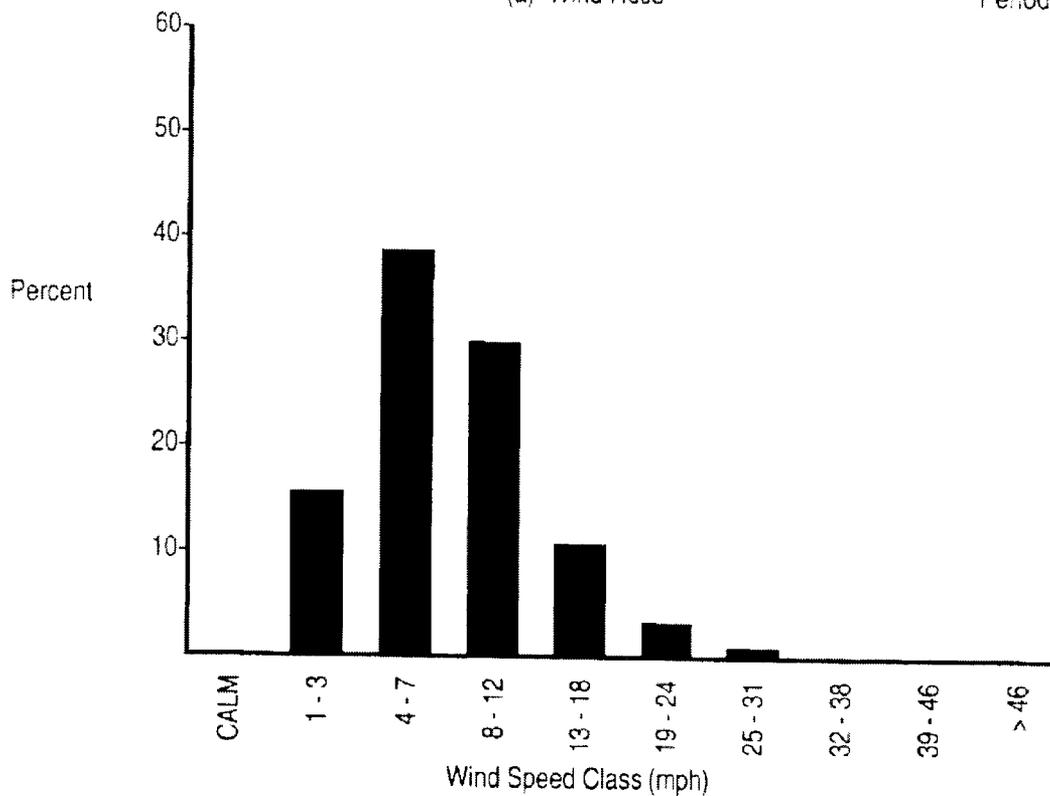
N



Station # 9 - FFTF

(a) Wind Rose

Period: 1/2009 - 12/2009



(b) Wind Speed Histogram

Table A-1. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 100-K Area (Station 29) at the 10-Meter Level. (3 sheets)

Wind Speed (m/sec)	Stability Class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
0.89	A	0.11	0.10	0.07	0.05	0.06	0.07	0.06	0.02	0.01	0.03	0.05	0.03	0.07	0.11	0.19	0.14	1.17
	B	0.12	0.10	0.10	0.09	0.08	0.09	0.06	0.07	0.04	0.04	0.05	0.12	0.11	0.17	0.18	0.21	1.63
	C	0.22	0.13	0.12	0.13	0.12	0.12	0.13	0.04	0.03	0.05	0.03	0.05	0.20	0.22	0.17	0.19	1.95
	D	0.47	0.39	0.45	0.58	0.50	0.50	0.37	0.34	0.31	0.34	0.29	0.42	0.60	0.63	0.65	0.47	7.31
	E	0.49	0.40	0.59	0.58	0.50	0.37	0.44	0.27	0.34	0.41	0.52	0.56	0.80	0.66	0.65	0.62	8.20
	F	0.40	0.45	0.55	0.63	0.66	0.61	0.55	0.54	0.47	0.53	0.81	1.11	1.26	0.83	0.68	0.59	10.67
	G	0.15	0.11	0.24	0.15	0.21	0.18	0.16	0.15	0.11	0.16	0.27	0.42	0.47	0.35	0.21	0.22	3.56
	Total	1.96	1.68	2.12	2.21	2.13	1.94	1.77	1.43	1.31	1.56	2.02	2.71	3.51	2.97	2.73	2.44	34.49
2.65	A	0.62	0.32	0.22	0.19	0.25	0.33	0.21	0.06	0.08	0.09	0.11	0.30	0.37	0.36	0.70	0.64	4.85
	B	0.30	0.21	0.15	0.16	0.16	0.17	0.21	0.05	0.05	0.07	0.16	0.21	0.33	0.28	0.29	0.34	3.14
	C	0.17	0.19	0.09	0.08	0.21	0.16	0.13	0.09	0.09	0.06	0.07	0.19	0.14	0.17	0.21	0.20	2.25
	D	0.54	0.27	0.37	0.33	0.49	0.58	0.59	0.44	0.27	0.15	0.24	0.56	1.01	0.72	0.54	0.45	7.55
	E	0.25	0.20	0.26	0.26	0.39	0.37	0.55	0.42	0.37	0.48	0.48	1.58	2.39	1.02	0.47	0.25	9.74
	F	0.17	0.11	0.14	0.20	0.30	0.16	0.25	0.30	0.24	0.27	0.47	1.59	1.57	0.57	0.26	0.14	6.74
	G	0.02	0.00	0.03	0.03	0.09	0.10	0.09	0.08	0.11	0.06	0.15	0.69	0.66	0.15	0.07	0.00	2.33
	Total	2.07	1.30	1.26	1.25	1.89	1.87	2.03	1.44	1.21	1.18	1.68	5.12	6.47	3.27	2.54	2.02	36.60
4.70	A	0.17	0.21	0.06	0.04	0.09	0.08	0.07	0.05	0.03	0.05	0.12	0.24	0.27	0.46	0.22	0.12	2.28
	B	0.02	0.04	0.02	0.04	0.05	0.09	0.05	0.04	0.03	0.03	0.02	0.08	0.11	0.14	0.10	0.02	0.88
	C	0.04	0.08	0.05	0.05	0.03	0.15	0.09	0.05	0.05	0.03	0.04	0.09	0.18	0.11	0.07	0.05	1.16
	D	0.21	0.07	0.02	0.03	0.10	0.22	0.35	0.11	0.07	0.13	0.15	0.43	0.85	0.40	0.19	0.25	3.58
	E	0.16	0.06	0.08	0.05	0.04	0.09	0.33	0.21	0.07	0.25	0.42	1.47	2.90	0.79	0.10	0.09	7.11
	F	0.01	0.00	0.01	0.00	0.01	0.05	0.10	0.12	0.03	0.00	0.11	0.56	0.65	0.06	0.01	0.00	1.72
	G	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.01	0.00	0.00	0.01	0.08	0.06	0.00	0.02	0.00	0.23
	Total	0.61	0.46	0.24	0.21	0.32	0.69	1.03	0.59	0.28	0.49	0.87	2.95	5.02	1.96	0.71	0.53	16.96

Table A-1. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 100-K Area (Station 29) at the 10-Meter Level. (3 sheets)

Wind Speed (m/sec)	Stability Class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
7.15	A	0.06	0.32	0.03	0.00	0.02	0.01	0.04	0.01	0.01	0.03	0.17	0.13	0.12	0.31	0.15	0.04	1.45
	B	0.00	0.03	0.05	0.02	0.03	0.00	0.03	0.01	0.00	0.02	0.03	0.07	0.11	0.20	0.04	0.00	0.64
	C	0.00	0.02	0.02	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.07	0.05	0.06	0.16	0.05	0.01	0.48
	D	0.08	0.03	0.04	0.05	0.03	0.02	0.04	0.04	0.04	0.14	0.24	0.15	0.45	0.67	0.23	0.02	2.27
	E	0.06	0.21	0.07	0.01	0.00	0.01	0.06	0.05	0.03	0.22	0.28	0.38	1.24	0.70	0.04	0.00	3.36
	F	0.02	0.01	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.00	0.01	0.05	0.07	0.02	0.00	0.00	0.21
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.22	0.62	0.21	0.08	0.09	0.07	0.18	0.12	0.08	0.42	0.80	0.83	2.05	2.06	0.51	0.07	8.41
9.80	A	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.03	0.08	0.05	0.32	0.13	0.01	0.65
	B	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.04	0.06	0.00	0.14
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.01	0.00	0.10	0.03	0.00	0.21
	D	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.08	0.09	0.03	0.16	0.30	0.04	0.00	0.73
	E	0.01	0.10	0.22	0.04	0.00	0.00	0.01	0.07	0.00	0.07	0.09	0.02	0.18	0.22	0.00	0.00	1.03
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.05
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.01	0.12	0.22	0.05	0.00	0.00	0.03	0.07	0.02	0.17	0.28	0.15	0.43	0.99	0.26	0.01	2.81
12.70	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.01	0.07	0.04	0.00	0.17
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.05
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.02
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.01	0.00	0.15
	E	0.01	0.09	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.04	0.01	0.00	0.31
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.01	0.09	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.03	0.06	0.29	0.06	0.00	0.70

Table A-1. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 100-K Area (Station 29) at the 10-Meter Level. (3 sheets)

Wind Speed (m/sec)	Stability Class	Wind direction toward:																Total	
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE		
15.60	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.05
19.00	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total	A	0.96	0.96	0.38	0.28	0.42	0.49	0.39	0.14	0.13	0.23	0.50	0.79	0.89	1.63	1.43	0.95	10.57	
	B	0.44	0.39	0.32	0.31	0.32	0.35	0.35	0.17	0.12	0.16	0.27	0.51	0.67	0.87	0.67	0.57	6.49	
	C	0.43	0.42	0.28	0.26	0.37	0.44	0.36	0.18	0.17	0.16	0.27	0.40	0.58	0.79	0.53	0.45	6.09	
	D	1.30	0.76	0.88	1.00	1.12	1.32	1.35	0.93	0.71	0.84	1.01	1.59	3.08	2.87	1.66	1.19	21.61	
	E	0.98	1.06	1.32	0.95	0.93	0.84	1.39	1.02	0.81	1.43	1.80	4.01	7.55	3.43	1.27	0.96	29.75	
	F	0.60	0.57	0.70	0.83	0.97	0.84	0.91	0.97	0.74	0.80	1.40	3.31	3.58	1.49	0.95	0.73	19.39	
	G	0.17	0.11	0.27	0.18	0.30	0.29	0.29	0.24	0.22	0.22	0.43	1.19	1.19	0.50	0.30	0.22	6.12	
	Total	4.88	4.27	4.15	3.81	4.43	4.57	5.04	3.65	2.90	3.84	5.68	11.80	17.54	11.58	6.81	5.07	100.02	

Table A-2. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 Area Meteorology Station (Station 21) at the 10-Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
0.89	A	0.06	0.08	0.06	0.04	0.03	0.10	0.04	0.07	0.08	0.04	0.10	0.00	0.10	0.04	0.05	0.07	0.96
	B	0.12	0.10	0.09	0.14	0.15	0.08	0.10	0.09	0.09	0.06	0.06	0.04	0.06	0.04	0.09	0.06	1.37
	C	0.16	0.12	0.18	0.15	0.14	0.07	0.09	0.02	0.05	0.08	0.07	0.03	0.08	0.06	0.10	0.13	1.53
	D	0.59	0.64	0.54	0.46	0.43	0.47	0.50	0.31	0.30	0.21	0.14	0.26	0.26	0.36	0.65	0.83	6.95
	E	0.43	0.25	0.28	0.20	0.23	0.31	0.32	0.37	0.50	0.42	0.47	0.55	0.65	0.62	0.66	0.48	6.74
	F	0.24	0.12	0.19	0.18	0.20	0.31	0.19	0.24	0.38	0.39	0.60	0.71	0.63	0.68	0.66	0.30	6.02
	G	0.18	0.04	0.10	0.12	0.10	0.13	0.09	0.13	0.07	0.04	0.09	0.12	0.12	0.20	0.24	0.15	1.92
	Total	1.78	1.35	1.44	1.29	1.28	1.47	1.33	1.23	1.47	1.24	1.53	1.71	1.90	2.00	2.45	2.02	25.49
2.65	A	0.60	0.46	0.30	0.37	0.39	0.52	0.39	0.20	0.14	0.11	0.17	0.12	0.16	0.17	0.36	0.45	4.91
	B	0.29	0.33	0.31	0.17	0.25	0.27	0.28	0.12	0.08	0.12	0.12	0.14	0.15	0.19	0.46	0.32	3.60
	C	0.32	0.13	0.11	0.18	0.11	0.21	0.13	0.09	0.10	0.11	0.18	0.12	0.13	0.16	0.37	0.46	2.91
	D	0.54	0.26	0.23	0.25	0.25	0.41	0.73	0.25	0.14	0.08	0.16	0.30	0.32	0.86	2.16	1.25	8.19
	E	0.26	0.21	0.11	0.16	0.22	0.38	0.51	0.41	0.30	0.26	0.48	0.96	2.05	2.75	1.78	0.59	11.43
	F	0.12	0.03	0.02	0.08	0.10	0.15	0.47	0.51	0.41	0.47	0.91	2.04	2.16	2.56	1.59	0.47	12.09
	G	0.03	0.05	0.03	0.03	0.06	0.06	0.09	0.12	0.21	0.14	0.31	0.64	0.50	0.88	0.58	0.17	3.90
	Total	2.16	1.47	1.11	1.24	1.38	2.00	2.60	1.70	1.38	1.29	2.33	4.32	5.47	7.57	7.30	3.71	47.03
4.70	A	0.32	0.27	0.13	0.04	0.08	0.04	0.11	0.01	0.02	0.09	0.30	0.29	0.13	0.27	0.56	0.28	2.94
	B	0.01	0.05	0.01	0.00	0.05	0.00	0.05	0.05	0.01	0.03	0.05	0.05	0.04	0.09	0.28	0.05	0.82
	C	0.04	0.04	0.06	0.00	0.06	0.07	0.05	0.01	0.07	0.03	0.03	0.06	0.05	0.09	0.33	0.07	1.06
	D	0.10	0.05	0.04	0.04	0.06	0.09	0.13	0.16	0.11	0.14	0.26	0.31	0.39	0.78	1.04	0.23	3.93
	E	0.08	0.21	0.06	0.03	0.03	0.03	0.08	0.07	0.17	0.14	0.69	0.92	1.38	2.30	1.58	0.09	7.86
	F	0.01	0.00	0.00	0.00	0.00	0.00	0.09	0.11	0.01	0.01	0.08	0.14	0.13	0.35	0.28	0.02	1.23
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.01	0.00	0.01	0.10	0.09	0.00	0.25
	Total	0.56	0.62	0.30	0.11	0.28	0.23	0.52	0.44	0.39	0.44	1.42	1.77	2.13	3.98	4.16	0.74	18.09

Table A-2. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 Arca Meteorology Station (Station 21) at the 10-Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
7.15	A	0.01	0.09	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.14	0.30	0.10	0.17	0.56	0.01	1.47
	B	0.01	0.01	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.10	0.03	0.10	0.16	0.00	0.51
	C	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.09	0.04	0.07	0.12	0.01	0.45
	D	0.00	0.01	0.03	0.01	0.01	0.00	0.00	0.00	0.03	0.21	0.25	0.29	0.15	0.53	0.66	0.00	2.18
	E	0.01	0.07	0.12	0.05	0.00	0.02	0.01	0.03	0.04	0.20	0.44	0.25	0.16	0.90	0.67	0.00	2.97
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.08
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Total	0.03	0.18	0.24	0.08	0.02	0.02	0.01	0.05	0.07	0.47	1.03	1.03	0.48	1.77	2.17	0.02	7.67
9.80	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09	0.01	0.03	0.06	0.00	0.22	
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.01	0.03	0.00	0.12	
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.00	0.00	0.02	0.01	0.09	
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.03	0.01	0.08	0.13	0.00	0.30
	E	0.00	0.06	0.19	0.06	0.00	0.00	0.00	0.02	0.01	0.03	0.10	0.04	0.00	0.06	0.12	0.00	0.69
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.06	0.19	0.06	0.00	0.00	0.00	0.03	0.01	0.07	0.24	0.18	0.04	0.20	0.35	0.00	1.43
12.70	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.03	0.00	0.00	0.00	0.00	0.07	
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02	
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.03	
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.03	
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.05	0.00	0.03	0.00	0.00	0.16

Table A-2. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 Area Meteorology Station (Station 21) at the 10-Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:														Total					
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE		SE	SSE			
15.60	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19.00	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	A	0.99	0.90	0.54	0.45	0.50	0.66	0.54	0.28	0.24	0.29	0.77	0.83	0.50	0.68	1.59	0.81	10.57			
	B	0.43	0.49	0.44	0.33	0.46	0.35	0.43	0.26	0.18	0.23	0.31	0.35	0.30	0.43	1.02	0.43	6.44			
	C	0.52	0.29	0.36	0.33	0.31	0.35	0.27	0.12	0.22	0.25	0.42	0.31	0.30	0.42	0.93	0.67	6.07			
	D	1.23	0.96	0.84	0.76	0.75	0.97	1.36	0.72	0.58	0.65	0.86	1.20	1.13	2.62	4.64	2.31	21.58			
	E	0.78	0.80	0.76	0.50	0.48	0.74	0.92	0.90	1.02	1.05	2.19	2.72	4.24	6.63	4.81	1.16	29.70			
	F	0.37	0.15	0.21	0.26	0.30	0.46	0.75	0.88	0.80	0.87	1.66	2.89	2.92	3.59	2.53	0.79	19.43			
	G	0.21	0.09	0.13	0.15	0.16	0.19	0.19	0.29	0.28	0.18	0.41	0.76	0.63	1.18	0.91	0.32	6.08			
	Total	4.53	3.68	3.28	2.78	2.96	3.72	4.46	3.45	3.32	3.52	6.62	9.06	10.02	15.55	16.43	6.49	99.87			

Table A-3. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 East Area (Station 6) at the 10 Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
0.89	A	0.07	0.05	0.09	0.10	0.07	0.08	0.05	0.04	0.02	0.06	0.05	0.01	0.02	0.12	0.05	0.04	0.92
	B	0.09	0.17	0.16	0.18	0.12	0.10	0.00	0.08	0.07	0.06	0.02	0.01	0.03	0.03	0.07	0.09	1.28
	C	0.12	0.11	0.17	0.12	0.23	0.09	0.11	0.07	0.04	0.03	0.04	0.04	0.03	0.06	0.01	0.14	1.41
	D	0.67	0.59	0.57	0.50	0.51	0.46	0.42	0.27	0.13	0.21	0.11	0.10	0.15	0.27	0.62	0.61	6.19
	E	0.25	0.14	0.19	0.27	0.31	0.28	0.34	0.34	0.31	0.31	0.28	0.32	0.48	0.53	0.59	0.36	5.30
	F	0.21	0.15	0.12	0.19	0.19	0.40	0.39	0.44	0.29	0.35	0.43	0.46	0.62	0.61	0.38	0.21	5.44
	G	0.09	0.05	0.04	0.09	0.10	0.15	0.20	0.10	0.13	0.09	0.12	0.10	0.09	0.15	0.22	0.19	1.91
	Total	1.50	1.26	1.34	1.45	1.53	1.56	1.51	1.34	0.99	1.11	1.05	1.04	1.42	1.77	1.94	1.64	22.45
2.65	A	0.44	0.57	0.22	0.19	0.49	0.54	0.37	0.20	0.04	0.06	0.15	0.18	0.18	0.16	0.31	0.40	4.50
	B	0.39	0.27	0.25	0.20	0.33	0.33	0.24	0.14	0.07	0.09	0.09	0.10	0.11	0.17	0.23	0.26	3.27
	C	0.32	0.15	0.08	0.17	0.17	0.33	0.21	0.09	0.07	0.03	0.13	0.12	0.11	0.19	0.19	0.31	2.67
	D	0.59	0.30	0.14	0.29	0.35	0.40	0.68	0.37	0.11	0.07	0.12	0.18	0.38	0.78	1.43	0.86	7.05
	E	0.25	0.14	0.09	0.10	0.23	0.34	0.50	0.60	0.36	0.25	0.31	0.57	1.02	2.06	1.17	0.34	8.33
	F	0.05	0.01	0.02	0.05	0.08	0.26	0.41	0.75	0.41	0.38	0.54	0.87	1.72	2.07	0.96	0.15	8.73
	G	0.00	0.01	0.01	0.01	0.04	0.09	0.23	0.18	0.16	0.12	0.09	0.21	0.44	0.75	0.19	0.02	2.55
	Total	2.04	1.45	0.81	1.01	1.69	2.29	2.64	2.33	1.22	1.00	1.43	2.23	3.96	6.18	4.48	2.34	37.10
4.70	A	0.37	0.31	0.12	0.07	0.10	0.19	0.16	0.12	0.03	0.08	0.14	0.25	0.17	0.20	0.37	0.18	2.86
	B	0.04	0.04	0.02	0.04	0.06	0.07	0.14	0.11	0.04	0.03	0.03	0.06	0.08	0.10	0.11	0.03	1.00
	C	0.10	0.08	0.02	0.03	0.10	0.09	0.09	0.08	0.04	0.03	0.05	0.07	0.05	0.08	0.24	0.11	1.26
	D	0.22	0.07	0.03	0.03	0.13	0.24	0.48	0.28	0.14	0.07	0.13	0.21	0.21	0.95	0.88	0.29	4.36
	E	0.14	0.14	0.03	0.03	0.05	0.16	0.21	0.30	0.16	0.15	0.39	0.52	1.75	3.49	0.76	0.12	8.40
	F	0.03	0.01	0.00	0.00	0.01	0.01	0.13	0.28	0.12	0.04	0.07	0.33	1.28	2.16	0.16	0.08	4.71
	G	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.06	0.04	0.00	0.03	0.12	0.32	0.89	0.04	0.00	1.55
	Total	0.90	0.65	0.22	0.20	0.45	0.77	1.25	1.23	0.57	0.40	0.84	1.56	3.86	7.87	2.56	0.81	24.14

Table A-3. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 East Area (Station 6) at the 10 Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total		
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE			
7.15	A	0.08	0.19	0.04	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.09	0.26	0.17	0.18	0.43	0.04	1.60
	B	0.02	0.03	0.04	0.01	0.01	0.00	0.02	0.02	0.01	0.00	0.03	0.03	0.07	0.03	0.07	0.11	0.18	0.01	0.59
	C	0.00	0.01	0.00	0.00	0.01	0.01	0.02	0.01	0.05	0.01	0.03	0.07	0.04	0.03	0.03	0.11	0.07	0.02	0.48
	D	0.05	0.02	0.05	0.01	0.02	0.01	0.05	0.09	0.07	0.16	0.13	0.25	0.26	0.83	0.40	0.06	0.06	2.46	
	E	0.15	0.21	0.07	0.01	0.00	0.02	0.02	0.06	0.07	0.19	0.52	0.63	0.86	2.69	0.38	0.01	0.01	5.89	
	F	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.01	0.00	0.07	0.03	0.08	0.18	0.02	0.00	0.00	0.47	
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.05
	Total	0.31	0.46	0.20	0.03	0.05	0.06	0.15	0.29	0.22	0.41	0.91	1.24	1.47	4.12	1.48	0.14	0.01	11.54	
9.80	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.13	0.03	0.07	0.25	0.01	0.01	0.52	
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.08	0.04	0.04	0.06	0.00	0.00	0.26	
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.06	0.03	0.04	0.06	0.00	0.00	0.24	
	D	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.23	0.17	0.09	0.52	0.27	0.00	0.00	1.34	
	E	0.00	0.12	0.11	0.02	0.00	0.00	0.00	0.02	0.04	0.08	0.20	0.13	0.06	0.55	0.12	0.00	0.00	1.45	
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.05	
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	
	Total	0.00	0.13	0.11	0.02	0.00	0.00	0.00	0.06	0.06	0.17	0.50	0.58	0.25	1.22	0.76	0.01	3.87		
12.70	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.01	0.04	0.00	0.00	0.12	
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.00	0.04	
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.08	0.04	0.00	0.00	0.00	0.16	
	E	0.01	0.04	0.09	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.05	0.05	0.02	0.03	0.01	0.00	0.00	0.31	
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Total	0.01	0.04	0.09	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.14	0.05	0.14	0.11	0.00	0.00	0.65		

Table A-3. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 East Area (Station 6) at the 10 Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
15.60	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.02	0.00	0.00	0.00	0.00	0.06
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.03
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.02
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.06	0.00	0.02	0.01	0.00	0.13
19.00	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	A	0.96	1.12	0.47	0.36	0.66	0.81	0.61	0.39	0.12	0.26	0.47	0.90	0.59	0.74	1.45	0.67	10.58
	B	0.54	0.51	0.47	0.43	0.52	0.50	0.40	0.35	0.19	0.20	0.19	0.30	0.34	0.46	0.67	0.39	6.46
	C	0.54	0.35	0.27	0.32	0.51	0.53	0.42	0.29	0.16	0.13	0.33	0.35	0.25	0.51	0.57	0.58	6.11
	D	1.53	0.99	0.79	0.83	1.01	1.11	1.63	1.01	0.46	0.55	0.73	0.95	1.09	3.43	3.65	1.82	21.58
	E	0.80	0.79	0.58	0.43	0.59	0.80	1.07	1.32	0.94	0.99	1.75	2.22	4.19	9.35	3.03	0.83	29.68
	F	0.30	0.17	0.14	0.24	0.29	0.68	0.95	1.53	0.84	0.77	1.11	1.70	3.70	5.02	1.52	0.44	19.40
	G	0.09	0.06	0.05	0.10	0.14	0.25	0.47	0.36	0.35	0.21	0.24	0.43	0.85	1.81	0.45	0.21	6.07
	Total	4.76	3.99	2.77	2.71	3.72	4.68	5.55	5.25	3.06	3.11	4.82	6.85	11.01	21.32	11.34	4.94	99.88

Table A-4. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 300 Area (Station 11) at the 10-Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total	
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE		
0.89	A	0.00	0.00	0.03	0.01	0.02	0.03	0.03	0.03	0.02	0.02	0.03	0.00	0.01	0.01	0.00	0.00	0.00	0.22
	B	0.02	0.02	0.02	0.01	0.06	0.02	0.08	0.06	0.03	0.03	0.01	0.02	0.00	0.01	0.03	0.01	0.01	0.41
	C	0.02	0.06	0.08	0.05	0.07	0.09	0.01	0.08	0.07	0.04	0.04	0.04	0.01	0.02	0.03	0.04	0.04	0.75
	D	0.23	0.20	0.18	0.12	0.17	0.26	0.33	0.43	0.29	0.31	0.26	0.26	0.21	0.28	0.22	0.39	0.49	4.37
	E	0.32	0.13	0.12	0.14	0.19	0.32	0.60	0.58	0.76	0.34	0.47	0.38	0.41	0.53	0.53	0.51	0.51	6.33
	F	0.37	0.22	0.16	0.11	0.14	0.34	0.72	0.64	0.44	0.38	0.15	0.34	0.37	0.69	0.76	0.57	0.57	6.40
	G	0.09	0.04	0.06	0.06	0.06	0.10	0.23	0.21	0.16	0.10	0.05	0.04	0.10	0.13	0.21	0.15	0.15	1.79
	Total	1.05	0.67	0.65	0.50	0.71	1.16	2.00	2.03	1.77	1.21	0.99	0.99	1.20	1.63	1.94	1.77	20.27	
2.65	A	0.06	0.08	0.26	0.49	0.76	0.55	0.28	0.17	0.16	0.24	0.16	0.11	0.04	0.02	0.01	0.01	3.40	
	B	0.08	0.12	0.16	0.31	0.44	0.52	0.39	0.14	0.19	0.27	0.13	0.08	0.02	0.01	0.02	0.10	2.98	
	C	0.19	0.15	0.17	0.12	0.26	0.28	0.32	0.22	0.17	0.27	0.18	0.05	0.04	0.03	0.02	0.11	2.58	
	D	0.78	0.53	0.19	0.15	0.21	0.70	1.23	0.65	0.47	0.53	0.39	0.18	0.13	0.27	1.04	1.38	8.83	
	E	0.95	0.28	0.10	0.08	0.17	1.00	1.62	1.27	1.00	0.77	0.46	0.46	0.42	0.45	1.01	1.55	11.59	
	F	0.47	0.09	0.03	0.01	0.06	0.86	2.57	0.98	0.67	0.35	0.21	0.12	0.15	0.40	0.86	0.98	8.81	
	G	0.21	0.02	0.00	0.02	0.06	0.23	0.77	0.34	0.15	0.08	0.05	0.00	0.03	0.10	0.28	0.52	2.86	
	Total	2.74	1.27	0.91	1.18	1.96	4.14	7.18	3.77	2.81	2.51	1.58	1.00	0.83	1.28	3.24	4.65	41.05	
4.70	A	0.20	0.52	0.65	0.34	0.25	0.37	0.36	0.16	0.33	0.54	0.42	0.17	0.04	0.11	0.03	0.04	4.53	
	B	0.13	0.27	0.22	0.13	0.09	0.14	0.20	0.07	0.16	0.36	0.26	0.11	0.03	0.01	0.01	0.04	2.23	
	C	0.14	0.17	0.08	0.05	0.08	0.10	0.14	0.11	0.13	0.22	0.24	0.11	0.04	0.02	0.05	0.13	1.81	
	D	0.36	0.16	0.10	0.02	0.06	0.18	0.40	0.21	0.40	0.76	0.55	0.19	0.11	0.11	0.67	0.67	4.95	
	E	1.08	0.20	0.02	0.05	0.02	0.26	0.45	0.38	0.58	0.89	0.97	0.62	0.25	0.26	0.46	1.02	7.51	
	F	0.54	0.10	0.00	0.02	0.00	0.41	0.42	0.15	0.34	0.42	0.39	0.04	0.02	0.05	0.14	0.56	3.60	
	G	0.23	0.03	0.00	0.00	0.00	0.22	0.27	0.05	0.11	0.11	0.05	0.01	0.00	0.00	0.02	0.24	1.34	
	Total	2.68	1.45	1.07	0.61	0.50	1.68	2.24	1.13	2.05	3.30	2.88	1.25	0.49	0.56	1.38	2.70	25.97	

Table A-4. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 300 Area (Station 11) at the 10-Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
7.15	A	0.14	0.19	0.09	0.00	0.01	0.05	0.03	0.01	0.09	0.20	0.30	0.27	0.05	0.14	0.10	0.03	1.70
	B	0.04	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.02	0.10	0.12	0.05	0.03	0.01	0.10	0.03	0.55
	C	0.10	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.08	0.14	0.16	0.11	0.04	0.01	0.01	0.04	0.71
	D	0.11	0.01	0.00	0.02	0.02	0.01	0.02	0.00	0.13	0.38	0.46	0.22	0.10	0.11	0.35	0.29	2.23
	E	0.16	0.03	0.04	0.03	0.01	0.00	0.06	0.06	0.14	0.43	0.63	0.16	0.06	0.13	0.49	0.19	2.62
	F	0.02	0.02	0.00	0.01	0.00	0.02	0.01	0.00	0.02	0.10	0.11	0.00	0.00	0.01	0.02	0.03	0.37
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.06
	Total	0.57	0.28	0.15	0.06	0.05	0.09	0.12	0.08	0.49	1.37	1.80	0.81	0.28	0.41	1.07	0.61	8.24
9.80	A	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.11	0.12	0.24	0.04	0.00	0.02	0.00	0.60
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.04	0.02	0.01	0.01	0.01	0.16
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.05	0.01	0.01	0.01	0.01	0.19
	D	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.24	0.14	0.05	0.09	0.19	0.06	0.96
	E	0.00	0.16	0.14	0.03	0.00	0.00	0.00	0.01	0.01	0.28	0.36	0.09	0.01	0.03	0.06	0.05	1.23
	F	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.08
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Total	0.05	0.20	0.15	0.03	0.00	0.00	0.00	0.03	0.06	0.58	0.88	0.56	0.13	0.14	0.29	0.13	3.23
12.70	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.01	0.00	0.00	0.00	0.09
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.01	0.02	0.01	0.00	0.00	0.09
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.01	0.00	0.00	0.05
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.11	0.02	0.02	0.03	0.04	0.00	0.25
	E	0.00	0.09	0.21	0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.00	0.00	0.00	0.01	0.00	0.42
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.06
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
	Total	0.00	0.09	0.21	0.01	0.00	0.00	0.00	0.00	0.01	0.13	0.27	0.08	0.07	0.05	0.05	0.00	0.97

Table A-4. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 300 Area (Station 11) at the 10-Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
15.60	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.03
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.02
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.03
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.03	0.02	0.00	0.00	0.01	0.00
19.00	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.02
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Total	A	0.43	0.81	1.03	0.84	1.04	1.00	0.70	0.37	0.62	1.15	1.02	0.86	0.19	0.27	0.16	0.08	10.57
	B	0.27	0.43	0.41	0.45	0.60	0.69	0.67	0.27	0.41	0.76	0.63	0.29	0.13	0.08	0.15	0.19	6.43
	C	0.45	0.39	0.34	0.22	0.41	0.47	0.47	0.41	0.45	0.70	0.71	0.34	0.17	0.11	0.14	0.33	6.11
	D	1.50	0.91	0.48	0.31	0.46	1.15	1.98	1.29	1.32	2.13	2.02	0.96	0.69	0.83	2.68	2.89	21.60
	E	2.51	0.89	0.63	0.34	0.39	1.58	2.73	2.30	2.49	2.75	2.96	1.71	1.15	1.40	2.56	3.32	29.71
	F	1.40	0.44	0.19	0.15	0.20	1.63	3.72	1.79	1.47	1.35	0.92	0.50	0.54	1.15	1.78	2.14	19.37
	G	0.53	0.09	0.06	0.08	0.12	0.55	1.27	0.61	0.43	0.32	0.18	0.05	0.13	0.23	0.51	0.91	6.07
	Total	7.09	3.96	3.14	2.39	3.22	7.07	11.54	7.04	7.19	9.16	8.44	4.71	3.00	4.07	7.98	9.86	99.86

Table A-5. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 400 Area (Station 9) at the 10-Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
0.89	A	0.04	0.03	0.01	0.03	0.06	0.09	0.06	0.04	0.02	0.03	0.01	0.04	0.03	0.02	0.03	0.02	0.56
	B	0.08	0.03	0.04	0.06	0.04	0.05	0.06	0.05	0.02	0.06	0.03	0.03	0.05	0.07	0.17	0.05	0.89
	C	0.08	0.04	0.01	0.09	0.07	0.05	0.06	0.04	0.07	0.05	0.02	0.03	0.01	0.01	0.04	0.05	0.72
	D	0.23	0.27	0.22	0.14	0.21	0.27	0.30	0.21	0.32	0.22	0.16	0.16	0.18	0.20	0.22	0.31	3.62
	E	0.26	0.18	0.22	0.15	0.18	0.13	0.20	0.25	0.33	0.33	0.37	0.39	0.42	0.36	0.50	0.32	4.59
	F	0.34	0.25	0.13	0.09	0.14	0.19	0.18	0.27	0.30	0.26	0.41	0.38	0.23	0.36	0.36	0.43	4.32
	G	0.08	0.06	0.04	0.06	0.02	0.03	0.05	0.05	0.11	0.09	0.05	0.07	0.12	0.10	0.09	0.16	1.18
	Total	1.11	0.86	0.67	0.62	0.72	0.81	0.91	0.91	1.17	1.04	1.05	1.10	1.04	1.12	1.41	1.34	15.88
2.65	A	0.27	0.24	0.28	0.28	0.43	0.45	0.38	0.20	0.31	0.21	0.13	0.07	0.15	0.10	0.07	0.11	3.68
	B	0.13	0.18	0.14	0.14	0.22	0.22	0.34	0.25	0.26	0.21	0.09	0.04	0.03	0.06	0.08	0.09	2.48
	C	0.29	0.12	0.14	0.14	0.16	0.19	0.14	0.23	0.31	0.14	0.04	0.05	0.08	0.09	0.06	0.14	2.32
	D	0.78	0.48	0.48	0.31	0.23	0.36	0.46	0.87	0.76	0.49	0.16	0.23	0.15	0.36	1.18	1.24	8.54
	E	0.61	0.40	0.36	0.39	0.22	0.27	0.72	0.96	1.13	0.99	0.53	0.60	0.51	0.67	1.24	1.04	10.64
	F	0.72	0.53	0.46	0.13	0.11	0.15	0.48	0.88	1.05	0.87	0.45	0.37	0.21	0.41	0.87	0.87	8.56
	G	0.25	0.28	0.10	0.05	0.06	0.05	0.10	0.19	0.24	0.18	0.05	0.04	0.07	0.15	0.39	0.31	2.51
	Total	3.05	2.23	1.96	1.44	1.43	1.69	2.62	3.58	4.06	3.09	1.45	1.40	1.20	1.84	3.89	3.80	38.73
4.70	A	0.46	0.51	0.17	0.11	0.08	0.12	0.22	0.12	0.60	0.46	0.20	0.11	0.13	0.19	0.10	0.13	3.71
	B	0.20	0.20	0.07	0.11	0.06	0.07	0.13	0.14	0.45	0.22	0.07	0.09	0.08	0.05	0.07	0.08	2.09
	C	0.25	0.12	0.04	0.07	0.05	0.07	0.10	0.16	0.37	0.34	0.08	0.05	0.05	0.04	0.07	0.16	2.02
	D	0.39	0.16	0.10	0.06	0.06	0.06	0.31	0.48	0.81	0.87	0.22	0.08	0.13	0.33	0.71	0.66	5.43
	E	0.37	0.22	0.16	0.03	0.01	0.04	0.36	0.99	1.29	1.05	0.44	0.30	0.44	0.94	1.89	0.67	9.20
	F	0.21	0.21	0.09	0.01	0.00	0.01	0.33	1.36	1.06	0.66	0.15	0.00	0.05	0.13	0.78	0.44	5.49
	G	0.12	0.10	0.05	0.00	0.00	0.00	0.14	0.57	0.40	0.14	0.03	0.01	0.00	0.00	0.28	0.15	1.99
	Total	2.00	1.52	0.68	0.39	0.26	0.37	1.59	3.82	4.98	3.74	1.19	0.64	0.88	1.68	3.90	2.29	29.93

Table A-5. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 400 Area (Station 9) at the 10 Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
7.15	A	0.13	0.20	0.08	0.00	0.01	0.01	0.05	0.04	0.12	0.41	0.20	0.18	0.12	0.14	0.22	0.03	1.94
	B	0.04	0.05	0.04	0.00	0.00	0.01	0.04	0.01	0.09	0.20	0.10	0.01	0.02	0.03	0.09	0.01	0.74
	C	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.18	0.24	0.04	0.06	0.04	0.05	0.03	0.04	0.74
	D	0.04	0.06	0.03	0.00	0.02	0.00	0.05	0.09	0.25	0.70	0.30	0.16	0.11	0.25	0.43	0.16	2.65
	E	0.11	0.03	0.07	0.02	0.00	0.00	0.04	0.13	0.23	0.83	0.54	0.21	0.15	0.54	0.57	0.02	3.49
	F	0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.13	0.21	0.35	0.10	0.00	0.00	0.02	0.02	0.01	0.88
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.12	0.12	0.09	0.00	0.00	0.01	0.00	0.03	0.00	0.38
	Total	0.34	0.35	0.22	0.02	0.03	0.03	0.23	0.54	1.20	2.82	1.28	0.62	0.45	1.03	1.39	0.27	10.82
9.80	A	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.12	0.11	0.17	0.03	0.02	0.05	0.00	0.55
	B	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.06	0.05	0.06	0.03	0.00	0.02	0.00	0.23
	C	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.03	0.02	0.02	0.04	0.04	0.00	0.20
	D	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.23	0.20	0.10	0.07	0.15	0.25	0.00	1.07
	E	0.00	0.10	0.12	0.01	0.00	0.00	0.00	0.01	0.02	0.42	0.25	0.03	0.00	0.14	0.16	0.00	1.26
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.03
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Total	0.01	0.14	0.14	0.02	0.01	0.00	0.00	0.01	0.07	0.90	0.65	0.38	0.15	0.35	0.52	0.00	3.35
12.70	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.07	0.00	0.00	0.00	0.00	0.10
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.05
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.02	0.00	0.00	0.00	0.00	0.08
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.11	0.02	0.01	0.05	0.05	0.00	0.00	0.27
	E	0.00	0.15	0.17	0.00	0.00	0.00	0.00	0.00	0.07	0.08	0.01	0.00	0.00	0.00	0.02	0.00	0.50
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.15	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.25	0.13	0.03	0.06	0.07	0.00	1.04

Table A-5. Annual Average Joint Frequency during 2009 (as percent of time) of Wind Speed, Stability Class, and Direction for the 400 Area (Station 9) at the 10-Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
15.60	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.00	0.00	0.00	0.00	0.06
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.02
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02
	E	0.00	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.06
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.03
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.03	0.00	0.02	0.01	0.00
19.00	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	G	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	A	0.91	0.99	0.55	0.42	0.58	0.67	0.71	0.40	1.07	1.26	0.68	0.67	0.46	0.47	0.47	0.29	10.60
	B	0.45	0.46	0.29	0.31	0.33	0.35	0.57	0.45	0.82	0.76	0.35	0.24	0.23	0.22	0.43	0.23	6.49
	C	0.63	0.30	0.19	0.30	0.28	0.32	0.31	0.45	0.93	0.83	0.25	0.23	0.20	0.24	0.25	0.39	6.10
	D	1.44	0.99	0.84	0.52	0.52	0.69	1.12	1.65	2.17	2.54	1.16	0.75	0.65	1.35	2.84	2.37	21.60
	E	1.35	1.08	1.14	0.61	0.41	0.44	1.32	2.34	3.00	3.69	2.22	1.54	1.52	2.65	4.38	2.05	29.74
	F	1.28	0.99	0.68	0.23	0.25	0.35	1.02	2.64	2.62	2.21	1.14	0.75	0.49	0.92	2.03	1.75	19.35
	G	0.45	0.44	0.19	0.11	0.08	0.08	0.30	0.93	0.87	0.51	0.13	0.12	0.20	0.25	0.79	0.62	6.07
	Total	6.51	5.25	3.88	2.50	2.45	2.90	5.35	8.86	11.48	11.80	5.93	4.30	3.75	6.10	11.19	7.70	99.95

Table A-6. Radionuclide Data on Clearance Type, Particle Size, Scavenging Coefficient, and Deposition Velocity Used for CAP88-PC Dose Calculations at the Hanford Site, 2009.

Radionuclide	Clearance type	Particle size (1m)	Scavenging Coefficient (per second)	Deposition Velocity (m/s)
³ H (vapor)	V	0	0	0
³ H (elemental)	G	0	0	0
¹⁴ C	M	1.0	1.60 E-06	1.80 E-03
⁶⁰ Co	M	1.0	1.60 E-06	1.80 E-03
⁸⁵ Kr	G	0	0	0
⁹⁰ Y	M	1.0	1.60 E-06	1.80 E-03
⁹⁰ Sr	M	1.0	1.60 E-06	1.80 E-03
⁹⁹ Tc	M	1.0	1.60 E-06	1.80 E-03
¹⁰⁶ Ru	M	1.0	1.60 E-06	1.80 E-03
¹²⁹ I	F	1.0	1.60 E-06	3.50 E-02
^{131m} Xe	G	0	0	0
¹³³ Xe	G	0	0	0
¹³⁵ Xe	G	0	0	0
^{137m} Ba	M	1.0	1.60 E-06	1.80 E-03
¹³⁷ Cs	F	1.0	1.60 E-06	1.80 E-03
¹⁵¹ Sm	M	1.0	1.60 E-06	1.80 E-03
¹⁵⁴ Eu	M	1.0	1.60 E-06	1.80 E-03
¹⁵⁵ Eu	M	1.0	1.60 E-06	1.80 E-03
¹⁸² Ta	M	1.0	1.60 E-06	1.80 E-03
¹⁸⁸ W	M	1.0	1.60 E-06	1.80 E-03
²²⁰ Rn	G	0	0	0
²²² Rn	G	0	0	0
²²⁸ Th	S	1.0	1.60 E-06	1.80 E-03
²³² Th	S	1.0	1.60 E-06	1.80 E-03
²³² U	M	1.0	1.60 E-06	1.80 E-03
²³³ U	M	1.0	1.60 E-06	1.80 E-03
²³⁴ U	M	1.0	1.60 E-06	1.80 E-03
²³⁵ U	M	1.0	1.60 E-06	1.80 E-03
²³⁶ U	M	1.0	1.60 E-06	1.80 E-03
²³⁸ U	M	1.0	1.60 E-06	1.80 E-03
²³⁸ Pu	M	1.0	1.60 E-06	1.80 E-03
²³⁹ Pu	M	1.0	1.60 E-06	1.80 E-03
²⁴¹ Pu	M	1.0	1.60 E-06	1.80 E-03
²⁴² Pu	M	1.0	1.60 E-06	1.80 E-03
²⁴¹ Am	M	1.0	1.60 E-06	1.80 E-03
²⁴³ Am	M	1.0	1.60 E-06	1.80 E-03
²⁴³ Cm	M	1.0	1.60 E-06	1.80 E-03
²⁵⁰ Cf ¹	M	1.0	1.60 E-06	1.80 E-03

¹ ²⁵⁰Cf is an EPA-approved surrogate for ²⁵²Cf, used here due to issues with CAP88-PC v3 computational errors related to ²⁵²Cf (PNNL-17847, Rev. 1, 2009).

Table A-7. Radionuclide Data on Decay Constant and Transfer Coefficient Used for CAP88-PC Dose Calculations at the Hanford Site, 2009. (2 sheets)

Radionuclide	Decay constant (per day)			Transfer coefficient	
	Radioactive	Surface	Water	Milk ¹	Meat ²
³ H (vapor)	1.54 E-04	5.48 E-05	0	0	0
³ H (elemental)	1.54 E-04	5.48 E-05	0	0	0
¹⁴ C	3.31 E-07	5.48 E-05	0	0	0
⁶⁰ Co	3.60 E-04	5.48 E-05	0	2.00 E-03	3.00 E-02
⁸⁵ Kr	1.77 E-04	5.48 E-05	0	0	0
⁹⁰ Y	2.60 E-01	5.48 E-05	0	6.00 E-05	2.00 E-03
⁹⁰ Sr	6.52 E-05	5.48 E-05	0	2.00 E-03	1.00 E-02
⁹⁹ Tc	8.91 E-09	5.48 E-05	0	1.00 E-03	1.00 E-04
¹⁰⁶ Ru	1.88 E-03	5.48 E-05	0	2.00 E-05	2.00 E-03
¹²⁹ I	1.21 E-10	5.48 E-05	0	1.00 E-02	4.00 E-02
^{131m} Xe	5.82 E-02	5.48 E-05	0	0	0
¹³³ Xe	1.32 E-01	5.48 E-05	0	0	0
¹³⁵ Xe	1.83 E+00	5.48 E-05	0	0	0
^{137m} Ba	3.91 E+02	5.48 E-05	0	5.00 E-04	2.00 E-04
¹³⁷ Cs	6.32 E-05	5.48 E-05	0	0	0
¹⁵¹ Sm	2.11 E-05	5.48 E-05	0	6.00 E-05	2.00 E-03
¹⁵⁴ Eu	2.21 E-04	5.48 E-05	0	6.00 E-05	2.00 E-03
¹⁵⁵ Eu	4.00 E-04	5.48 E-05	0	6.00 E-05	2.00 E-03
¹⁸³ Ta	1.36 E-01	5.48 E-05	0	5.00 E-06	5.00 E-06
¹⁸⁸ W	9.99 E-03	5.48 E-05	0	3.00 E-04	4.00 E-02
²²⁰ Rn	1.08 E+03	5.48 E-05	0	0	0
²²² Rn	1.81 E-01	5.48 E-05	0	0	0
²²⁸ Th	9.92 E-04	5.48 E-05	0	5.00 E-06	1.00 E-04
²³² Th	1.35 E-13	5.48 E-05	0	5.00 E-06	1.00 E-04
²³² U	2.64 E-05	5.48 E-05	0	4.00 E-04	8.00 E-04
²³³ U	1.20 E-08	5.48 E-05	0	4.00 E-04	8.00 E-04
²³⁴ U	7.76 E-09	5.48 E-05	0	4.00 E-04	8.00 E-04
²³⁵ U	2.70 E-12	5.48 E-05	0	4.00 E-04	8.00 E-04
²³⁶ U	8.10 E-11	5.48 E-05	0	4.00 E-04	8.00 E-04
²³⁸ U	4.25 E-13	5.48 E-05	0	4.00 E-04	8.00 E-04
²³⁸ Pu	2.16 E-05	5.48 E-05	0	1.00 E-06	1.00 E-04
²³⁹ Pu	7.88 E-08	5.48 E-05	0	1.00 E-06	1.00 E-04
²⁴¹ Pu	1.32 E-04	5.48 E-05	0	1.00 E-06	1.00 E-04
²⁴² Pu	5.04 E-09	5.48 E-05	0	1.00 E-06	1.00 E-04

Table A-7. Radionuclide Data on Decay Constant and Transfer Coefficient Used for CAP88-PC Dose Calculations at the Hanford Site, 2009. (2 sheets)

Radionuclide	Decay constant (per day)			Transfer coefficient	
	Radioactive	Surface	Water	Milk ¹	Meat ²
²⁴¹ Am	4.39 E 06	5.48 E 05	0	2.00 E 06	5.00 E 05
²⁴³ Am	2.57 E 07	5.48 E 05	0	2.00 E 06	5.00 E 05
²⁴³ Cm	6.66 E 05	5.48 E 05	0	2.00 E 06	2.00 E 05
²⁵⁰ Cf ³	1.45 E-04	5.48 E-05	0	2.00 E-06	6.00 E-05

¹ Fraction of animal's daily intake of nuclide that appears in each liter of milk, in days/L.

² Fraction of animal's daily intake of nuclide that appears in each kg of meat, in days/kg.

³ ²⁵⁰Cf is a surrogate for ²⁵²Cf (PNNL-17847, Rev. 1, 2009).

Table A-8. Radionuclide Data on Concentration Uptake Factor and Gastric Intestinal Uptake Fraction Used for CAP88-PC Dose Calculations at the Hanford Site, 2009. (2 sheets)

Radionuclide	Concentration uptake factor		GI uptake fraction	
	Forage ¹	Edible ²	Inhalation	Ingestion
³ H (vapor)	0	0	1.00 E+00	1.00 E+00
³ H (elemental)	0	0	1.00 E+00	1.00 E+00
¹⁴ C	0	0	1.00 E+00	1.00 E+00
⁶⁰ Co	2.00 E+00	8.00 E-02	1.00 E-01	1.00 E-01
⁸⁵ Kr	0	0	0	0
⁹⁰ Y	1.00 E-01	2.00 E-03	1.00 E-04	1.00 E-04
⁹⁰ Sr	4.00 E+00	3.00 E-01	3.00 E-01	3.00 E-01
⁹⁹ Tc	4.00 E+01	5.00 E+00	5.00 E-01	5.00 E-01
¹⁰⁶ Ru	2.00 E-01	3.00 E-02	5.00 E-02	5.00 E-02
¹²⁹ I	1.00 E-01	2.00 E-02	1.00 E+00	1.00 E+00
^{131m} Xe	0	0	0	0
¹³³ Xe	0	0	0	0
¹³⁵ Xe	0	0	0	0
^{137m} Ba	1.00 E-01	1.00 E-02	2.00 E-01	2.00 E-01
¹³⁷ Cs	1.00 E+00	2.00 E-01	1.00 E+00	1.00 E+00
¹⁵¹ Sm	1.00 E-01	2.00 E-03	5.00 E-04	5.00 E-04
¹⁵⁴ Eu	1.00 E-01	2.00 E-03	5.00 E-04	5.00 E-04
¹⁵⁵ Eu	1.00 E-01	2.00 E-03	5.00 E-04	5.00 E-04
¹⁸³ Ta	1.00 E-01	2.00 E-03	1.00 E-03	1.00 E-03
¹⁸⁸ W	3.00 E+00	8.00 E-01	3.00 E-01	3.00 E-01
²²⁰ Rn	0	0	0	0
²²² Rn	0	0	0	0
²²⁸ Th	1.00 E-01	1.00 E-03	5.00 E-04	5.00 E-04
²³² Th	1.00 E-01	1.00 E-03	5.00 E-04	5.00 E-04
²³² U	1.00 E-01	2.00 E-03	2.00 E-02	2.00 E-02
²³³ U	1.00 E-01	2.00 E-03	2.00 E-02	2.00 E-02
²³⁴ U	1.00 E-01	2.00 E-03	2.00 E-02	2.00 E-02
²³⁵ U	1.00 E-01	2.00 E-03	2.00 E-02	2.00 E-02
²³⁶ U	1.00 E-01	2.00 E-03	2.00 E-02	2.00 E-02
²³⁸ U	1.00 E-01	2.00 E-03	2.00 E-02	2.00 E-02
²³⁸ Pu	1.00 E-01	1.00 E-03	5.00 E-04	5.00 E-04
²³⁹ Pu	1.00 E-01	1.00 E-03	5.00 E-04	5.00 E-04
²⁴¹ Pu	1.00 E-01	1.00 E-03	5.00 E-04	5.00 E-04

Table A-8. Radionuclide Data on Concentration Uptake Factor and Gastric Intestinal Uptake Fraction Used for CAP88-PC Dose Calculations at the Hanford Site, 2009. (2 sheets)

Radionuclide	Concentration uptake factor		GI uptake fraction	
	Forage ¹	Edible ²	Inhalation	Ingestion
²⁴² Pu	1.00 E 01	1.00 E 03	5.00 E 04	5.00 E 04
²⁴¹ Am	1.00 E 01	1.00 E 03	5.00 E 04	5.00 E 04
²⁴³ Am	1.00 E 01	1.00 E 03	5.00 E 04	5.00 E 04
²⁴³ Cm	1.00 E 01	1.00 E 03	5.00 E 04	5.00 E 04
²⁵⁰ Cf ³	1.00 E 01	1.00 E 03	5.00 E 04	5.00 E 04

GI = gastric intestinal

¹ Concentration factor for uptake of nuclide from soil for pasture and forage, in pCi/kg dry weight per pCi/kg dry soil.

² Concentration factor for uptake of nuclide from soil by edible parts of crops, in pCi/kg wet weight per pCi/kg dry soil.

³ ²⁵⁰Cf is a surrogate for ²⁵²Cf (PNNL-17847, Rev. 1, 2009).

Table A-9. Exposure and Consumption Data for the Hanford Site. (2 sheets)

FOOD SOURCE FOR THE MAXIMALLY EXPOSED INDIVIDUAL
(Fraction of food produced at indicated location)

<u>Food</u>	<u>Local</u>	<u>Regional</u>	<u>Imported</u>
Vegetable	1.000	0.000	0.000
Meat	1.000	0.000	0.000
Milk	1.000	0.000	0.000

VALUES FOR RADIONUCLIDE-INDEPENDENT VARIABLES

HUMAN INHALATION RATE (cm^3/hr) = $9.70 \text{ E}+05$

SOIL PARAMETERS

Effective surface density, $\text{kg}/\text{sq m}$, dry weight
(assumes 15-cm plow layer) = $2.24 \text{ E}+02$

BUILDUP TIMES

For activity in soil (yr) = $5.00 \text{ E}+01$
For radionuclides deposited on ground/water (d) = 365

DELAY TIMES

Ingestion of pasture grass by animals (hr) = $0.00 \text{ E}+00$
Ingestion of stored feed by animals (hr) = $2.40 \text{ E}+03$
Ingestion of leafy vegetables by man (hr) = $2.40 \text{ E}+01$
Ingestion of produce by man (hours) = $1.20 \text{ E}+02$
Transport time from animal feed-milk-man (d) = $2.00 \text{ E}+00$
Time from slaughter to consumption (d) = $1.50 \text{ E}+01$

WEATHERING

Removal rate constant for physical loss (per hr) = $3.00 \text{ E}-03$

CROP EXPOSURE DURATION

Pasture grass (hr) = $7.20 \text{ E}+02$
Crops/leafy vegetables (hr) = $2.16 \text{ E}+03$

AGRICULTURAL PRODUCTIVITY

Grass-cow-milk-man pathway (kg/m^2) = $3.00 \text{ E}-01$
Produce/leafy veg for human consumption (kg/m^2) = $2.00 \text{ E}+00$

FALLOUT INTERCEPTION FRACTIONS

Vegetables = $2.50 \text{ E}-01$
Pasture = $2.50 \text{ E}-01$

GRAZING PARAMETERS

Fraction of year animals graze on pasture = $7.50 \text{ E}-01$
Fraction of daily feed that is pasture grass when animal grazes on pasture = $1.00 \text{ E}+00$

ANIMAL FEED CONSUMPTION FACTORS

Contaminated feed/forage (kg/day , dry weight) = $1.56 \text{ E}+01$

Table A-9. Exposure and Consumption Data for the Hanford Site. (2 sheets)

DAIRY PRODUCTIVITY

Milk production of cow (L/day) = 1.10 E+01

MEAT ANIMAL SLAUGHTER PARAMETERS

Muscle mass of animal at slaughter (kg) = 2.00 E+02

Fraction of herd slaughtered (per day) = 3.81 E-03

DECONTAMINATION

Fraction of radioactivity retained after washing
or leafy vegetables and produce = 1.00 E+00

FRACTIONS GROWN IN GARDEN OF INTEREST

Produce ingested = 1.00 E+0

Leafy vegetables ingested = 1.00 E+00

INGESTION RATIOS:

IMMEDIATE SURROUNDING AREA/TOTAL WITHIN AREA

Vegetables = 1.00 E+00

Meat = 1.00 E+00

Milk = 1.00 E+00

MINIMUM INGESTION FRACTIONS FROM OUTSIDE AREA

(Minimum fractions of food types from outside area listed below are actual fixed values.)

Vegetables = 0.00 E+00

Meat = 0.00 E+00

Milk = 0.00 E+00

HUMAN FOOD UTILIZATION FACTORS

Produce ingestion (kg/yr) = 2.20 E+02

Milk ingestion (L/yr) = 2.70 E+02

Meat ingestion (kg/yr) = 9.80 E+01

Leafy vegetable ingestion (kg/yr) = 3.00 E+01

SWIMMING PARAMETERS

Fraction of time spent swimming = 1.00 E-02

Dilution depth for water (cm) = 1.00 E+00

EXTERNAL DOSE

Ground surface contamination correction factor = 1.00 E+00

Table A-10. Hanford Site Meteorological Data — General Site Information.

HEIGHT OF LID

LIDAI = 1,000 m

RAINFALL RATE

RR = 15.9 cm/yr

AVERAGE AIR TEMPERATURE

A = 12.0 degrees C (53.6 degrees F; 285.2 K)

SURFACE ROUGHNESS LENGTH

z = 0.010 m

VERTICAL TEMPERATURE GRADIENTS: (TG) (K/m)

STABILITY E	0.073
STABILITY F	0.109
STABILITY G	0.146

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APPENDIX B

**RADIOACTIVE MATERIALS USED AND/OR POTENTIALLY USED
AT THE HANFORD SITE IN 2009**

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Table B-1. Radionuclides Used and/or Potentially Used at the Hanford Site in 2009. (2 sheets)

Ac-225	Bi-211	Cm-245	Ga-67	Ir-192	Nd-147	Po-210
Ac-227	Bi-212	Cm-246	Ga-72	K-40	Ni-56	Po-211
Ac-228	Bi-213	Cm-247	Gd-148	K-42	Ni-59	Po-212
Ag-108	Bi-214	Cm-248	Gd-149	Kr-81	Ni-63	Po-213
Ag-108m	Bk-249	Co-56	Gd-151	Kr-81m	Ni-65	Po-214
Ag-109m	Bk-250	Co-57	Gd-152	Kr-83m	Np-235	Po-215
Ag-110	Br-82	Co-58	Gd-153	Kr-85	Np-236	Po-216
Ag-110m	Br-82m	Co-60	Ge-68	Kr-85m	Np-237	Po-218
Ag-111	Br-83	Cr-49	H-3	Kr-87	Np-238	Pr-143
Al-26	Br-84	Cr-51	Hf-175	Kr-88	Np-239	Pr-144
Al-28	Br-84m	Cr-55	Hf-178m	Kr-89	Np-240	Pr-144m
Am-241	Br-85	Cs-131	Hf-181	Kr-90	Np-240m	Pu-234
Am-242	C-11	Cs-132	Hf-182	La-138	O-15	Pu-236
Am-242m	C-14	Cs-134	Hg-203	La-140	Os-191	Pu-237
Am-243	C-15	Cs-134m	Ho-166	La-141	P-32	Pu-238
Am-245	Ca-41	Cs-135	Ho-166m	La-142	P-33	Pu-239
Ar-37	Ca-45	Cs-136	I-122	Lu-177	Pa-231	Pu-240
Ar-39	Ca-47	Cs-137	I-123	Mg-27	Pa-233	Pu-241
Ar-41	Cd-109	Cs-138	I-125	Mg-28	Pa-234	Pu-242
Ar-42	Cd-113	Cs-139	I-129	Mn-52	Pa-234m	Pu-243
As-74	Cd-113m	Cu-64	I-130	Mn-54	Pb-209	Pu-244
As-76	Cd-115	Dy-165	I-130m	Mn-56	Pb-210	Ra-223
At-217	Cd-115m	Er-169	I-131	Mo-93	Pb-211	Ra-224
Au-195	Ce-139	Er-171	I-132	Mo-99	Pb-212	Ra-225
Au-198	Ce-141	Es-254	I-132m	N-13	Pb-214	Ra-226
Ba-131	Ce-142	Eu-150	I-133	Na-22	Pd-103	Ra-228
Ba-133	Ce-143	Eu-152	I-133m	Na-24	Pd-107	Rb-83
Ba-133m	Ce-144	Eu-152m	I-134	Nb-91	Pd-109	Rb-84
Ba-137m	Cf-249	Eu-154	I-134m	Nb-91m	Pm-145	Rb-86
Ba-139	Cf-250	Eu-155	I-135	Nb-92	Pm-146	Rb-87
Ba-140	Cf-251	Eu-156	In-106	Nb-93m	Pm-147	Rb-88
Ba-141	Cf-252	Eu-157	In-111	Nb-94	Pm-148	Rb-89
Ba-142	Cl-36	F-18	In-113m	Nb-95	Pm-148m	Rb-90
Be-7	Cm-241	Fe-55	In-114	Nb-95m	Pm-149	Rb-90m
Bc-10	Cm-242	Fe-59	In-114m	Nb-97	Pm-151	Re-186
Bi-207	Cm-243	Fr-221	In-115	Nb-97m	Po-208	Re-187
Bi-210	Cm-244	Fr-223	In-115m	Nd-144	Po-209	Re-188

Table B-1. Radionuclides Used and/or Potentially Used at the Hanford Site in 2009. (2 sheets)

Rh-102	Sn-121m	Th-227	Xe-127
Rh-103m	Sn-123	Th-228	Xe-127m
Rh-105	Sn-125	Th-229	Xe-129m
Rh-105m	Sn-126	Th-230	Xe-131m
Rh-106	Sr-85	Th-231	Xe-133
Rn-219	Sr-87m	Th-232	Xe-133m
Rn-220	Sr-89	Th-233	Xe-135
Rn-222	Sr-90	Th-234	Xe-135m
Rn-224	Sr-91	Ti-44	Xe-137
Ru-97	Sr-92	Ti-45	Xe-138
Ru-103	Ta-179	Ti-51	Y-88
Ru-105	Ta-182	Tl-201	Y-90
Ru-106	Ta-183	Tl-204	Y-90m
S-35	Tb-160	Tl-206	Y-91
Sb-122	Tb-161	Tl-207	Y-91m
Sb-124	Tc-95m	Tl-208	Y-92
Sb-125	Tc-97	Tl-209	Y-93
Sb-126	Tc-97m	Tm-170	Yb-164
Sb-126m	Tc-98	Tm-171	Yb-169
Sb-127	Tc-99	U-232	Yb-175
Sb-129	Tc-99m	U-233	Yb-177
Sc-46	Tc-101	U-234	Zn-65
Sc-47	Tc-121	U-235	Zn-69
Sc-75	Tc-121m	U-236	Zn-69m
Sc-79	Tc-123	U-237	Zr-88
Sc-79m	Tc-123m	U-238	Zr-89
Si-31	Tc-125m	U-239	Zr-93
Sm-145	Tc-127	U-240	Zr-95
Sm-146	Tc-127m	V-48	Zr-97
Sm-147	Tc-129	V-49	
Sm-151	Tc-129m	W-181	
Sm-153	Tc-131	W-185	
Sm-157	Tc-131m	W-187	
Sn-113	Tc-132	W-188	
Sn-117m	Tc-133	Xe-122	
Sn-119m	Tc-133m	Xe-123	
Sn-121	Tc-134	Xe-125	

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